

Rare Habitats on the Nantahala and Pisgah National Forests

Information presented in this draft report is considered under development. It may be incomplete and is likely unedited. An updated version of this report will be posted when it becomes available.

Rare habitats are defined as those plant communities that are rare on the Nantahala and Pisgah National Forests (NFs) or rare in the southern Appalachians with global rank of G3 or less. Plant communities were grouped based on landscape or plant similarities. They include separate plant communities as well as subtype variation within communities. All the types/subtypes were determined either from NatureServe.org or from the 2012 Guide to the Natural Communities of North Carolina, 4th Approximation by Michael Schafale. The number of unique habitat sites across the forest was determined from the Biotics database as maintained by the NC Natural Heritage Program and information with forest personal and cooperators. The exact number of sites can be fluid as new locations are identified. NatureServe Global Conservation Status Ranks definitions of the G ranks are:

- G1 Critically imperiled**—at very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
- G2 Imperiled**—at high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.
- G3 Vulnerable**—at moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.
- G4 Apparently Secure**—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
- G5 Secure**—common; widespread and abundant.

The rare habitats vary by rarity and the number of sites documented across the Nantahala and Pisgah NFs. The rarest habitats, by number of sites on the national forest, include calcareous oak-walnut forest, serpentine barren, upland pools, floodplain pools, and canebrakes (Table 1). Globally, the rarest habitats that occur on the two national forests are grassy balds, heath balds, serpentine barrens, beech gap forest, calcareous oak-walnut forest, and various subtypes of high and low elevation rocky summits.

Table 1. The number of sites by rare habitat on the Nantahala and Pisgah NF and on other lands within the surrounding 18 county area.

Habitat	Type/subtype G rank Range	Nantahala and Pisgah NF Sites	Other Land Sites in the 18 county area
Grassy Balds	G1	9	6
Heath Balds	G1 - G2	12	19
Beech Gap/Boulderfield	G1 - G2G3	24	23
High Elevation Rock Outcrops	G1- G2G3	48	30
Montane Cliffs	G2 - G3G4	47	50
Low Elevation Rock Outcrops	G1 - G3?	15	26

Habitat	Type/subtype G rank Range	Nantahala and Pisgah NF Sites	Other Land Sites in the 18 county area
Carolina Hemlock Bluff/Forest	G1G2 - G2	28	24
White Pine Forest	G2G3	9	2
Calcareous Oak-Walnut Forest	G1Q	1	2
Serpentine Barren	G1	1	1
Red Cedar/Shale Woodlands	G2	14	15
Low Elevation Glade	G1G2 - G2G3	15	45
Upland/Vernal Pool	G1Q	3	0
Southern Appalachian Bog	G1G2 - G2?	33	68
Seeps	G2 - G3?	48	14
Spray Cliff	G1G2 - G2?	21	31
Floodplain Pool	G3	1	9
Rocky Bar and Shore	G3 - G4	15	20
Canebrakes	G2?	1	3
Caves/Mines	?	29	17

Unique habitats occur across all of the ranger districts; however, they are unevenly distributed across the forest (Figure 1). Areas with more than one rare habitat include Roan Mountain, Linville Gorge Wilderness, Hot Springs area, Harmon Den, Panthertown Valley, Highlands area, the northern Nantahala Mountains, the Nantahala Gorge, and Joyce Kilmer Wilderness.

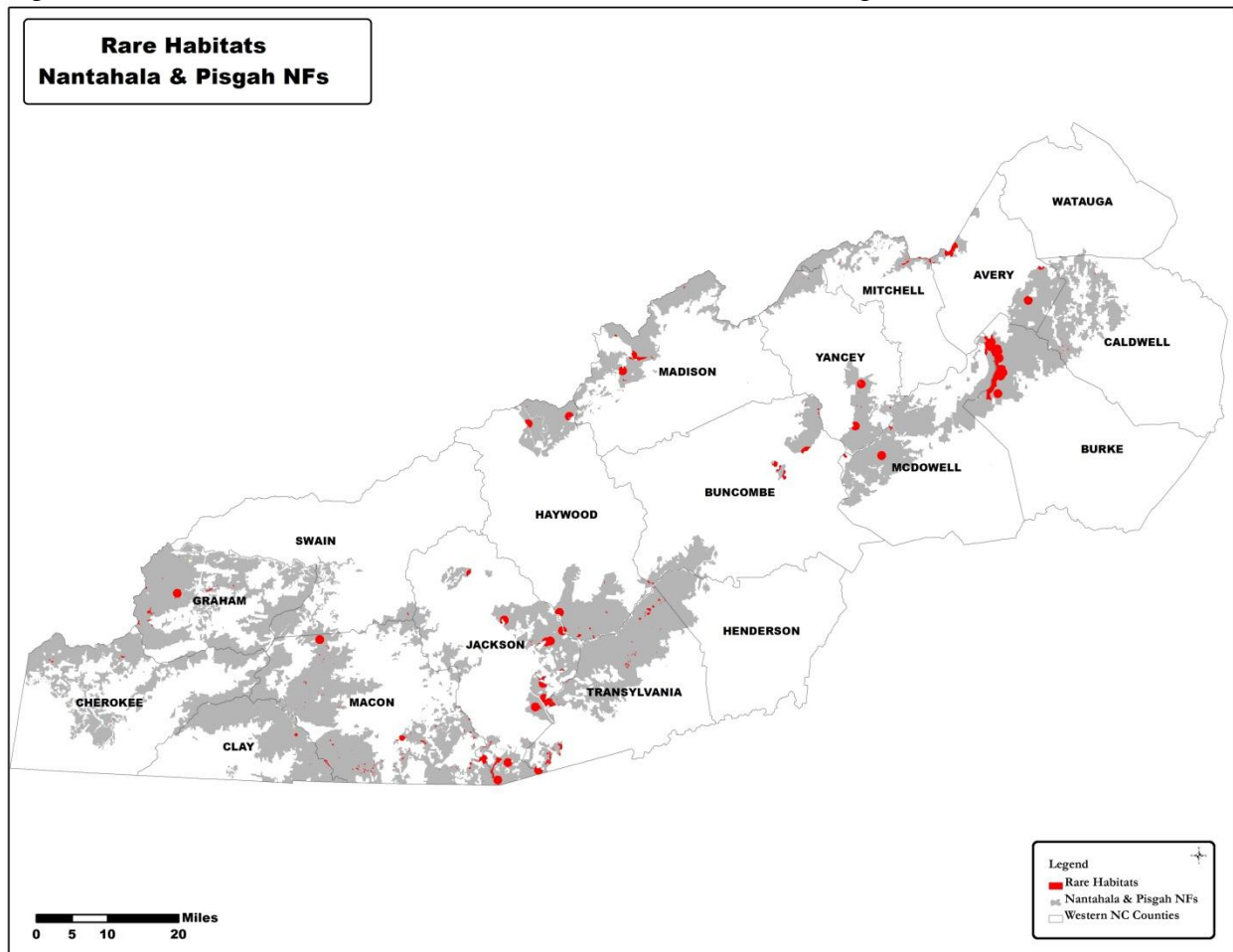
The habitats vary by the number of rare species that occur within them. High elevation rocky summits have the greatest concentration of federally listed species followed by low elevation rock outcrops and montane cliffs. The more mesic habitats, such as southern Appalachian bogs, seeps, and spray cliffs, have the highest plant diversity. Half of the rare species within these sites are mosses. A few habitats have no documented rare species, such as white pine forests, Carolina hemlock bluffs, and canebrakes.

Table 2. The number of listed species by rare habitat on the Nantahala and Pisgah National Forest and the number of sites within designated areas. *Number of Species of Conservation Concern is yet to be determined (TBD).

Habitat Groups	Federally Listed	SCC	Designated Sites	% Designated
Grassy Balds	1	TBD*	8	90%
Heath Balds	0	TBD	12	90%
Beech Gap/Boulderfield	1	TBD	14	60%
High Elevation Rock Outcrops	4	TBD	18	35%
Montane Cliffs	2	TBD	11	15%
Low Elevation Rock Outcrops	2	TBD	9	55%

Habitat Groups	Federally Listed	SCC	Designated Sites	% Designated
Carolina Hemlock Bluff/Forest	0	TBD	15	50%
White Pine Forest	0	TBD	4	45%
Calcareous Oak-Walnut Forest	0	TBD	0	0%
Serpentine Barren	0	TBD	1	50%
Red Cedar/Shale Woodlands	0	TBD	4	7%
Low Elevation Glade	0	TBD	3	20%
Upland/Vernal Pool	0	TBD	3	100%
Southern Appalachian Bog	1	TBD	10	29%
Seeps	0	TBD	18	41%
Spray Cliff	1	TBD	11	61%
Floodplain Pool	0	TBD	0	0%
Rocky Bar and Shore	1	TBD	11	65%
Canebrakes	0	0	0	0%
Caves/Mines			8	28%

Figure 1. Distribution of rare habitats across the Nantahala and Pisgah National Forests.



Many of the 20 rare habitats on the two forests are well-represented within the “designated areas” identified in the 1987 Plan, though some are not. For example, all the upland pools on the two forests are within designated areas as are the majority of the grassy bald and heath bald habitats. Also, for subtypes of rare habitats, some may be better represented within designated areas than others.

Management activities have varied during the last fifteen years across the habitats. The majority have not had active management. Most activities within the habitats include management of invading shrubs and trees in grassy balds, control of invasive plants and woody invasion in selected southern Appalachian bogs, control of invasive plants in rocky bar and shore habitats and a few seeps, treatment of hemlock wooly adelgids with neonicotinoid insecticides and beetle releases, and periodic prescribed burns within the serpentine barrens.

Threats are variable within the different habitats. The greatest threats include the decline and death of Carolina hemlocks by hemlock wooly adelgids within Carolina hemlocks bluffs and forests, woody expansion and non-native invasive species spread into the two open subtypes of southern Appalachian bogs, and woody succession in all three subtypes of grassy balds.

Grassy Balds:

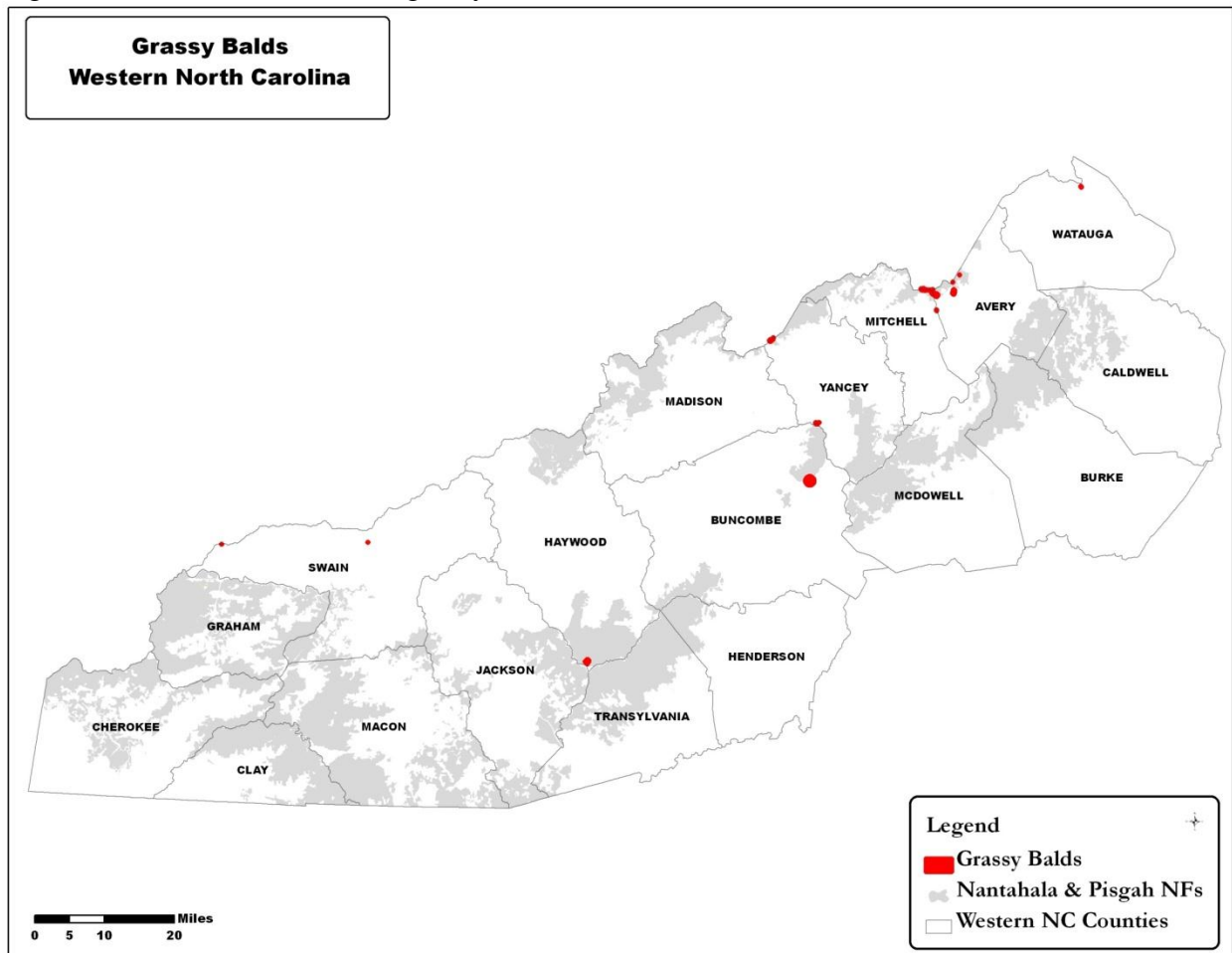
Grassy Balds occur at high elevations, typically above 5000 feet elevation, on ridgetops, knobs, and gentle slopes (Newell and Peet 1996, Natureserve 2013). Soils are moist due to moisture, from rain, snow storms, and fog deposition (Schafale and Weakley 1990). Grassy balds can be divided into three subtypes: grass, sedge, or alder (Schafale 2012). The grass subtype is dominated by mountain oat grass (*Danthonia compressa*), wavy hairgrass (*Avenella flexuosa*), and mountain cinquefoil (*Sibbaldia tridentata*). Pennsylvania sedge dominates the sedge subtype with lesser amounts of *Carex debilis* var. *rudgei* and hay-scented fern (*Dennstaedtia punctilobula*). Green alder (*Alnus viridis* ssp. *crispus*), a species widely disjunct from its more northern range, dominates the alder subtype with mountain oat grass often underneath. All three subtypes have a global rank of G1. The green alder subtype has the most restricted range, only occurring at Roan Mountain in North Carolina and Tennessee (Natureserve 2013). The sedge subtype also has a restricted range, as it is known to occur only on Roan Mountain and one other peak in North Carolina. The grass subtype is known to occur in Virginia, primarily on Whitetop Mountain.

In western North Carolina, grassy balds are disproportionately concentrated on federal ownership including the national forest, the Blue Ridge Parkway and the Great Smoky Mountains National Park. Fifteen sites have been identified (Figure 1). Seven sites occur on the Nantahala and Pisgah NFs, with five of these at Roan Mountain, which some ecologists speculate may be the only naturally occurring grassy balds in the southern Appalachians (Schafale and Weakley 1990, Natureserve 2013). This determination is due to the presence of various northern disjunct light-loving rare plant species, such as Schweinitz's ragwort (*Packera schweinitzii*) on the balds but not located within any nearby open or partially open habitats such as high elevation rocky summits. There are at least an additional 20 grassy balds, such as Max Patch, Huckleberry, Goat, or Siler Bald, on the Nantahala and Pisgah NFs.

Across western NC, all of the alder subtype is on national forest land, as well as half of the sedge subtype and grass subtype sites. Probably greater than 75% of the grass subtype, occurs on Roan Mountain, across both the Pisgah NF and the adjacent Cherokee NF. Patch sizes of this subtype are 3-10 times larger at Roan Mountain compared to other sites (Landfire 2009).

Various rare species are known to occur in grassy balds. Two federally listed plant species, spreading avens (*Geum radiatum*) and Roan Mountain bluet (*Houstonia montana*), are known to occur in areas with shallow soils.

Figure 2. The extent of natural grassy balds across western North Carolina.



For the grassy bald habitats on Nantahala and Pisgah NFs, a high proportion occur within existing designated areas. All of the alder and sedge subtypes occur within the Roan Mountain designated area. All except one grassy subtype, representing more than 80% of its extent, occur within designated areas.

The historical extent of grassy balds is uncertain, because speculation exists on the origin of grassy balds (Wells 1937). Theories on creation and maintenance have been attributed to grazing animals, trampling, clearing by early settlers, Native American prescribed burning or natural wildfires, historical climatic change, and/or insect damage (Lindsay 1976, McLeod 1988, DeSelm, H. R., and N. Murdock. 1993, Wiegler & Knowles 1999, Schafale & Weakley 1990, NatureServe 2013). All grassy balds have experienced some degree of grazing, periodic woody plant invasion, and management activities.

All the grassy bald areas are threatened by invasion from woody plants (Barden 1978, Lindsay & Bratton 1980). During the last 30 years, different management techniques have been implemented to address this invasion. Experimental prescribed burning resulted in expansion of smooth blackberry (*Rubus canadensis*), and there is some speculation that the removal of the duff layer leads to invasion by woody species (Murdock 1986). Herbicide application to

blackberries, goat or cow grazing or browsing, and mechanical mowing either with weed eaters or track mowers have helped to maintain the grassy balds.

At Roan Mountain, all three of the subtypes occur and there is uncertainty on what the natural distribution should be, particularly the distribution of the alder subtype because some of the active management during the last 20 years has affected it. Given the history of land use, in particular grazing by sheep until the early 1960's, it will be difficult to determine the natural range of variation for grassy balds (Brown 1941, Bauer 2012).

Heath Balds:

Heath balds are treeless areas on exposed steep slopes and ridges or flatter areas with thin soil bordering rock outcrops (Risk 1993, Schafale 2012). Four subtypes are described: low elevation, southern mixed, Catawba rhododendron and Carolina rhododendron. Heath balds are generally restricted to high elevation, above 4,800 feet, except for the low elevation subtype, which has been located at less than 4,000 feet elevation (Schafale 2012). The three other subtypes have been distinguished by their primary shrub dominants: mountain fetterbush (*Pieris floribunda*), Catawba rhododendron, Carolina rhododendron. The four subtypes that occur on the national forests vary in global rank from G1 (southern mixed), to G2 (Carolina and Catawba Rhododendron subtypes), and G2G3 (low elevation).

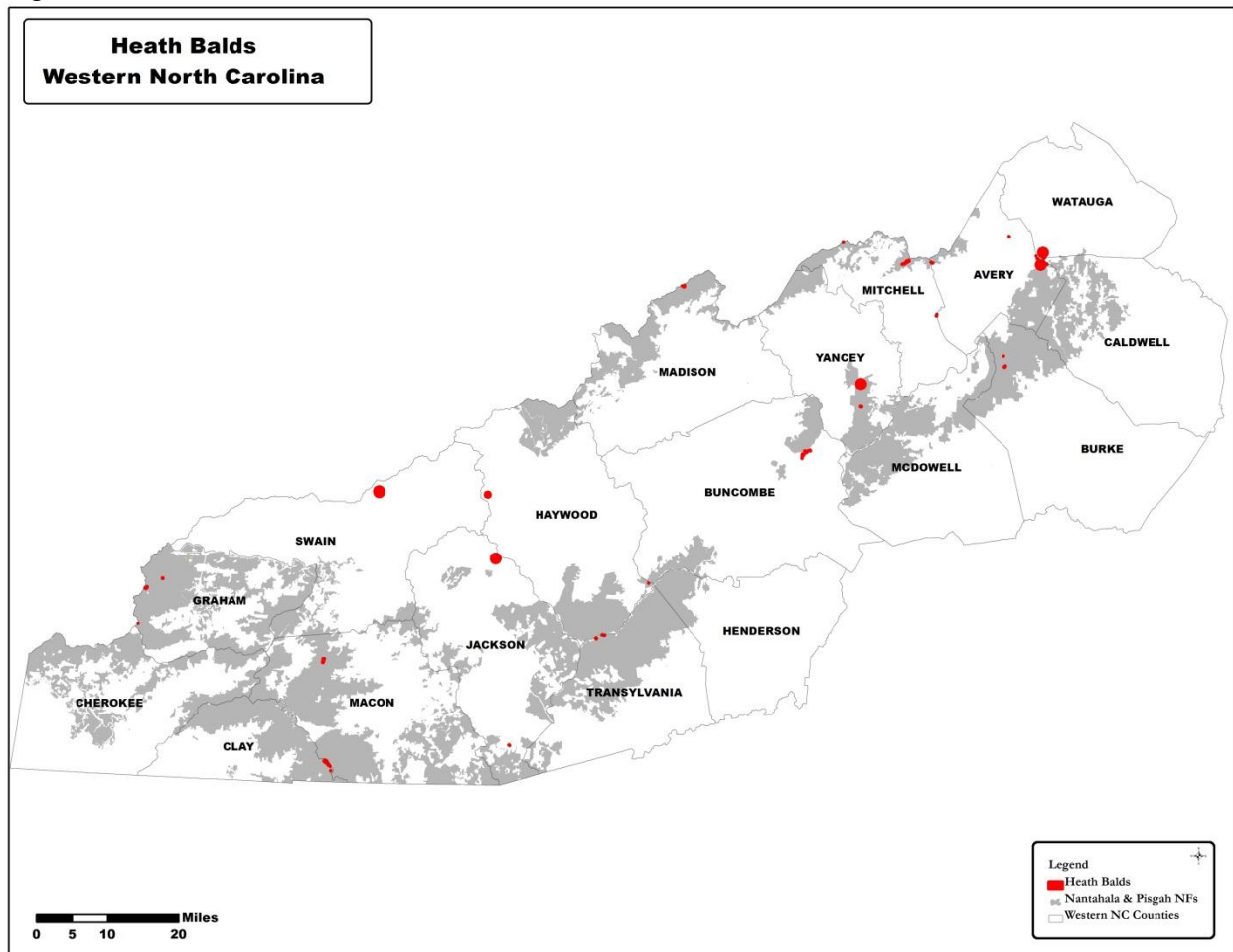
In western North Carolina, most heath balds occur on federal ownership, in particular the Nantahala and Pisgah NFs and the two National Park Service units; the Blue Ridge Parkway and the Great Smoky Mountains National Park.

Of the subtypes in western NC, all the known Carolina rhododendron occurrences are on national forest lands, along with 50% of the low elevation subtype and about 30% of the sites for both southern mixed and Catawba rhododendron subtypes.

Very few rare plant species are known to occur in heath balds, and no federally listed species are known to occur. There are no known rare animal species known to occur in heath balds.

A high proportion of the heath bald communities on the two national forests are within existing designated areas. All of the sites for three subtypes, Carolina Rhododendron, Catawba Rhododendron, and low elevation, are within designated areas, and 80% of the southern mixed sites are within designated areas. Given their high shrub density and remoteness, few threats are evident for heath balds.

Figure 3. The extent of heath bald habitats across western North Carolina.



Beech Gaps and Boulderfield Forests:

These two habitats are typically found above 4,000 feet elevation, occurring up to 5800 feet elevation. Beech gaps are found within concave slopes at high elevation gaps (Natureserve 2013). Consequently, they tend to be strongly affected by high winds, often resulting in dwarfed or gnarled trees. In comparison, boulderfields are located within more mesic steep slopes with large boulders, which can have seepage underneath (Schafale and Weakley 1992, Chafin and Jones 1989). Wind swept American beech is the dominant tree within beech gaps with little shrub development and variable herbaceous diversity depending on soil moisture. In comparison, boulderfields have a more open tree canopy of yellow birch, yellow buckeye, and black birch. Shrubs, particularly gooseberries, and vines, are abundant as are bryophytes covering the boulders (Natureserve 2013). Herbaceous cover is relatively sparse given the limited pockets of soil.

Beech gaps have a limited distribution from Tennessee and North Carolina with possible inclusion in Georgia and a global rank of G1. In contrast, boulderfield forest has a broader distribution including Georgia, Tennessee, North Carolina and possibly Virginia and Kentucky. However, this is still an imperiled habitat with a global rank of G2G3. In western North

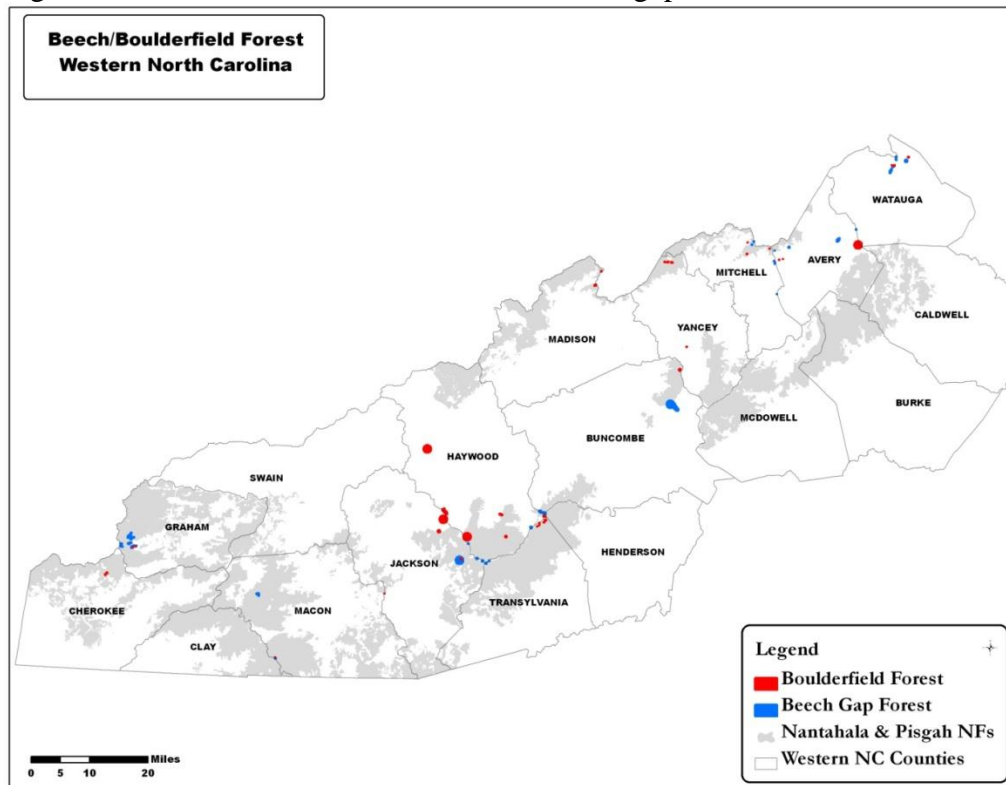
Carolina, beech gap forest is known to occur across nine sites on the Nantahala and Pisgah NFs and 17 sites on other lands within the surrounding 18-county area (Figure 4). There are 15 boulderfield sites on the national forests and six on other lands. Both of these rare habitats are dispersed across high-elevation forests of western North Carolina, generally in patches less than five acres.

The federally endangered northern flying squirrel occurs in these habitats.

Eight of the boulderfield forests sites and six of the beech gap forests, comprising about 60% of both habitats across the Nantahala and Pisgah NFs, occur within designated areas.

Both rare habitats appear to be stable and are maintained by the extreme cold or wind at high elevations. Beech gaps may be persisting as a result of allelopathic effect of beech litter that may interfere with growth of other native trees (Fuller 1977). Threats to the habitats include non-native invasive plant species, particularly oriental bittersweet in the moister boulderfield forests. No management activities have been implemented in these habitats during the last 10 years.

Figure 4. Distribution of boulderfield and beech gap forests in western North Carolina.



High Elevation Rock Outcrop:

High elevation rock outcrops occur on scattered summits and bluffs (Wiser et al. 1996, Schafale and Weakley 19990). Two major types are recognized: high elevation granitic domes and high elevation rocky summits. High elevation rocky summits often have a flat upper bench and a vertical cliff with extensive bare rock. Herbs are the dominant vegetation type. The rocky summits are distinguished by vegetation, rock substrate, or elevation. Three sites are known to

occur on the Pisgah and Nantahala NFs and the surrounding 18-county area. The high elevation rocky summits are further divided into four subtypes: the anakeesta rock subtype, the typic subtype, the high peak subtype, and the dry lichen subtype.

The anakeesta rock subtype is known to occur in the Great Smoky Mountains National Park but is not documented on national forest lands. The subtype is dominated by Michaux's saxifrage (*Saxifraga michauxi*), mountain dwarf-dandelion (*Krigia montana*), poverty oat grass (*Danthonia spicata*), and a variety of other common and rare herbaceous plants (Natureserve 2013). In contrast, the high peak subtype includes species that only occur at high elevations such as wretched sedge (*Carex misera*) or clustered goldenrod (*Solidago glomerata*). Various lichens, such as *Umbilicaria caroliniana* and crustose lichens occur almost entirely within the dry lichen subtype (Schafale 2012). The dry lichen subtype tends to occur on smooth outcrops with limited soil development. Consequently, they are close in appearance to high elevation granitic domes. High elevation granitic domes are large expanses of smooth granite with exfoliation surfaces which also exclude dense soil development thereby inhibiting most woody species. Characteristic plant species include large mats of twisted-hair spikemoss (*Selaginella tortipila*) and scattered clumps of mountain dwarf-dandelion and granite dome bluet (*Houstonia longifolia* var. *glabra*).

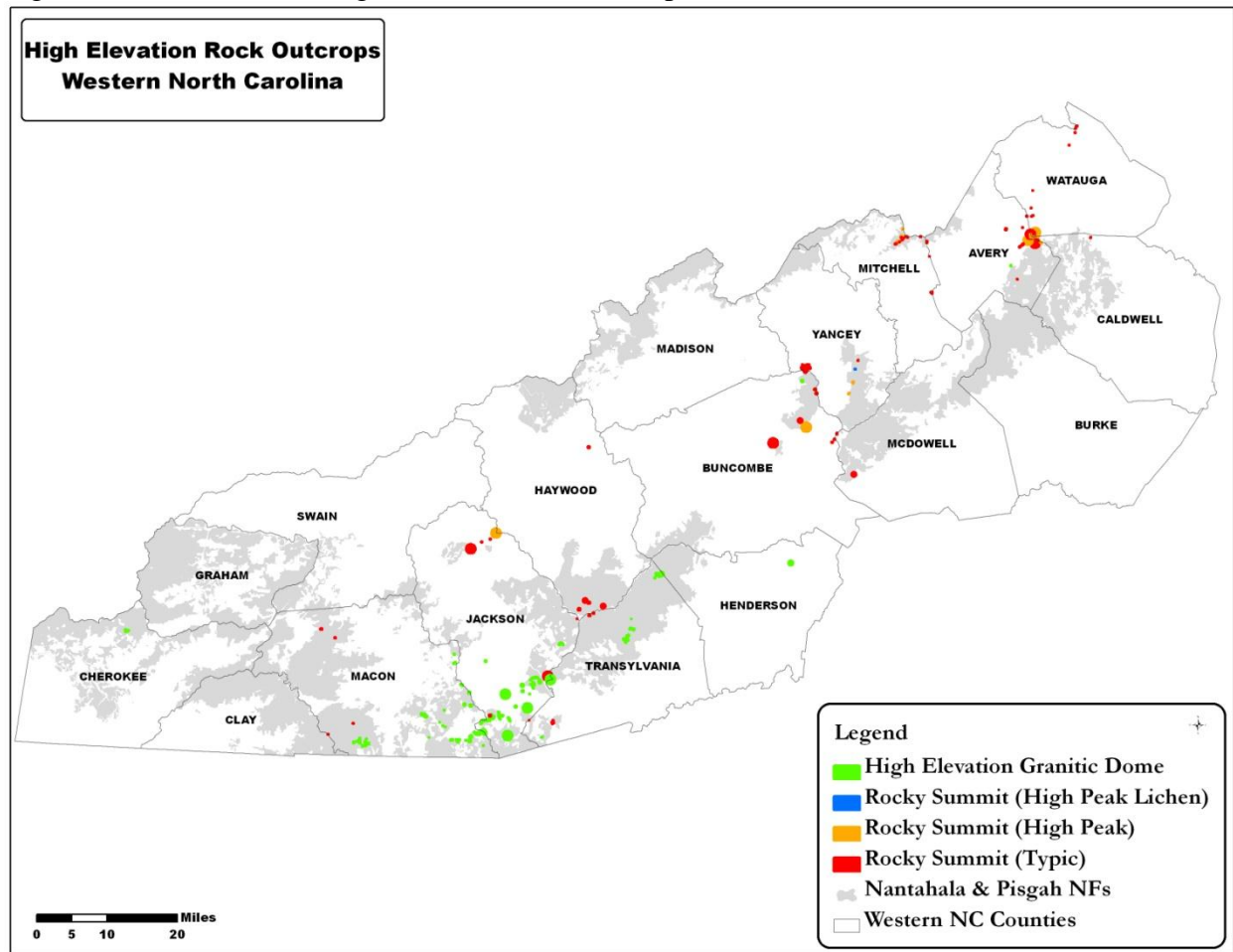
High elevation rock outcrops are naturally rare across their range. High elevation granitic domes are concentrated on the Blue Ridge escarpment of Macon, Jackson, Transylvania, and Henderson Counties with a few outliers (Figure 5). These habitats are known to occur from Georgia and the Carolinas, with possible occurrences in Tennessee.

High elevation rocky summits are restricted in their range, occurring in Tennessee and North Carolina (Natureserve 2013). The typic and lichen subtypes are ranked G2, while the high peak type subtype is G1. In the planning area, few examples of the lichen subtype have been identified. Two of the three known sites occur on national forest lands. The high peak subtype is restricted to Grandfather Mountain, Roan Mountain, Black Mountain, the Smoky Mountains, and Plott Balsam Mountain. The majority of the high peak sites are non on national forest lands, although one site is known to occur at Roan Mountain on the Pisgah NF. The typic subtype is more evenly distributed across western North Carolina with just over half of the known sites occurring on the Nantahala and Pisgah NFs.

A relatively large number of rare species are known to occur within this rare habitat. Four federally listed plants are documented in rocky summits or granitic domes, all four of which occur on the national forest.

For high elevation rocky summits, high peak and dry lichen subtypes occur completely within designated areas. Just over half of the typic subtype sites occur within designated areas. Less than 20% of the high elevation granitic domes occur within designated areas.

Figure 5. Distribution of high elevation rock outcrops in western North Carolina.



Given the spectacular views present at many of these sites, trampling of vegetation from recreational use poses the greatest threat to these unique rock communities (Natureserve 2013). Closure orders to prevent recreational impacts to rare species have been implemented at several Roan mountain sites. Monitoring has indicated an increase in rare plant populations as a result of the closures. Long-term climatic changes may heavily impact these high elevation dependent communities

Montane Cliffs:

Montane cliffs occur on steep to vertical rocky outcrops on mid and lower slopes (Schafale 2012, Schafale and Weakley 1999). Rock cliffs are large enough and high enough to not be shaded by forested vegetation, but they occur in landscape positions that are more protected than exposed rocky summits. Three subtypes are distinguished within the planning area, primarily differentiated by soils and geology, which influence the vegetation. These subtypes are acidic herb, mafic, and calcareous.

The acidic herb subtype is generally 90% bare felsic rock with a mix of mosses, lichen and vascular plants including mountain spleenwort (*Asplenium montanum*) and hairy alumroot (*Heuchera villosa*) (Natureserve 2013). Wall rue (*Asplenium ruta-muraria*), purple cliffbrake

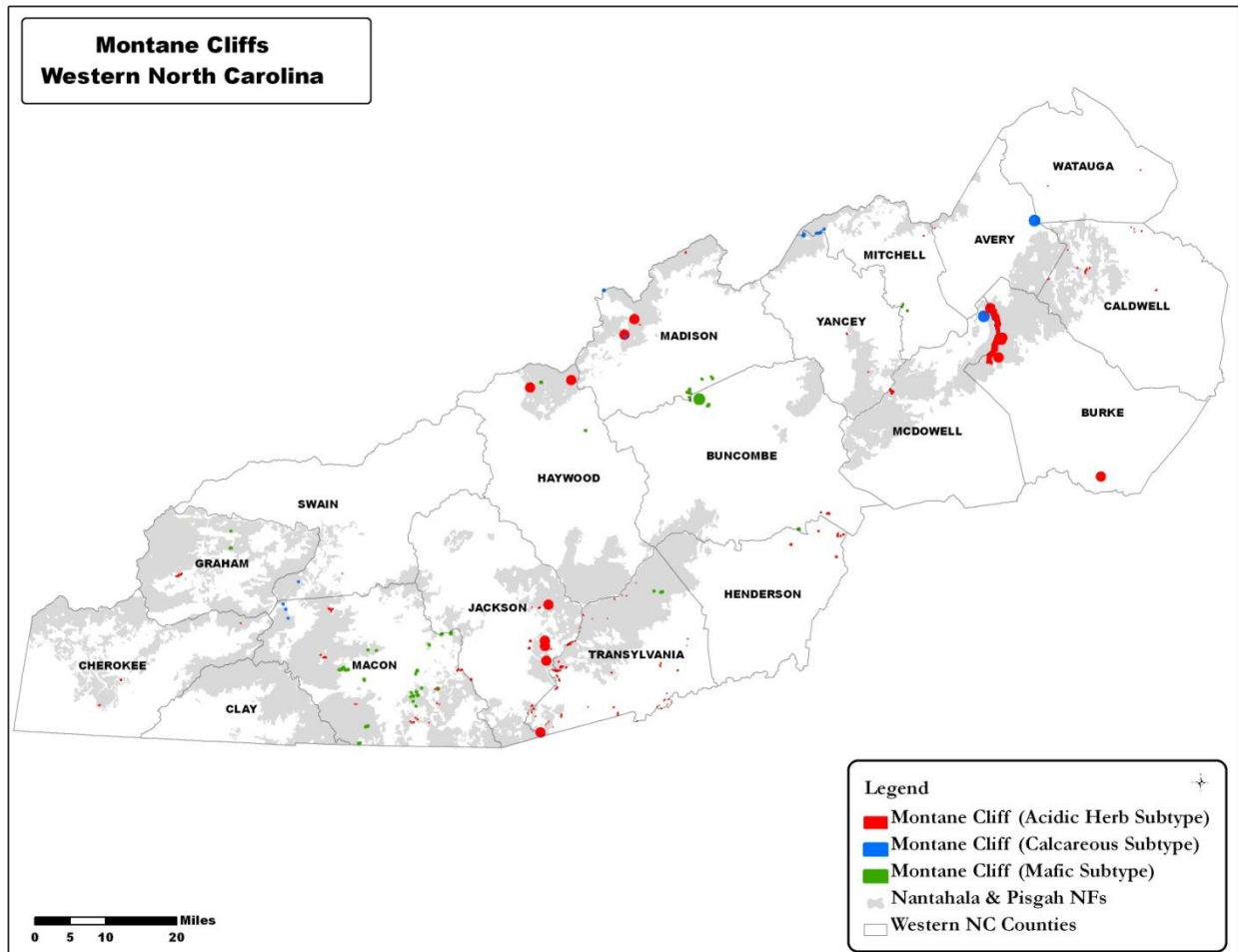
(*Pellaea atropurpurea*), and columbine (*Aquilegia canadensis*) are part of the calciphilic plants present within the 10% vegetated cover of the calcareous subtype. The mafic subtype occurs on amphibolite or other mafic substrate. It is similar to the calcareous subtype but typically includes species such as scentless mock orange (*Philadelphus inodorus*), slippery elm (*Ulmus rubra*), bladder fern (*Cystopteris protrusa*), walking fern (*Asplenium rhizophyllum*), or maidenhair spleenwort (*Asplenium trichomanes*) (Schafale 2012).

The three subtypes vary in their global rank from G3 to G3G4. The calcareous subtype occurs across the Appalachian Mountains from Pennsylvania to southern Alabama. In contrast, the acidic herb subtype is more restricted in the southern Blue Ridge and adjacent upper Piedmont. The mafic subtype occurs within the southern Blue Ridge, the southern Ridge and Valley, and the Cumberlands.

The acidic herb subtype is the most common subtype in western NC, with 67 separate sites scattered across the 18-county area, 32 of which occur on the Nantahala and Pisgah NFs. The calcareous subtypes are much less common in the planning area. Five of the seven delineated calcareous sites within the planning area are on the national forests. Twenty-three mafic subtype sites have been delineated, ten of which are on the Nantahala and Pisgah NFs.

A large number of rare plant species are known to occur in montane cliff habitats, including two federally listed plants that are documented on the national forests. Just under half of montane cliff habitats occur within designated areas on the forest. Trampling from rock climbers poses the greatest threat to these rare habitats. Given the steepness of the slopes, the impacts from recreational use are not as great as rocky summits.

Figure 6. Distribution of montane cliffs in western North Carolina.



Low Elevation Rock Outcrops:

Low elevation rock outcrops occur as two major types: low elevation granitic domes and low elevation rocky summits (Schafale and Weakley 1990). Three low elevation rocky summit subtypes are distinguished by rock substrate (Natureserve 2013, Schafale 2012): basic, acidic, and quartzite. Both the basic and acidic subtypes are dominated by Michaux's saxifrage, however, the basic subtypes also have more calcium-loving species such as hairy lipfern (*Cheilanthes lanosa*), Allegheny stonecrop (*Hylotelephium telephoides*), columbine (*Aquilegia canadensis*), and hoary mountain-mint (*Pycnanthemum incanum*). Other saxifrage species and little bluestem occur with the acidic subtype.

The quartzite subtype occurs along flat ledges in the Linville Gorge area (Newell and Peet 2005). It is dominated by the short shrub sand-myrtle (*Kalmia buxifolia*) with scattered occurrences of twisted spikemoss, parosol sedge (*Carex umbellata*), and mountain golden-heather (*Hudsonia montana*).

Low elevation granitic domes are distinguished by smooth exfoliating rock surfaces with an absence of rock crevices (Schafale 2012). Herbaceous vegetation such as rock spikemoss (*Selaginella rupestris*), pineweed (*Hypericum gentianoides*), and hairsedge (*Bulbostylis capillaris*) dominate on low elevation granitic domes (Natureserve 2013).

Within the low-elevation rocky summit subtypes the acidic subtype is the most common, occurring from Virginia to South Carolina and Georgia. It has a global rank of G3. There are 13 delineated sites in the planning area, most of which occur on national forest lands. All of the quartzite subtype known sites occur on the Pisgah NF in the Linville Gorge area (Schafale 2012). This subtype has a global rank of G1.

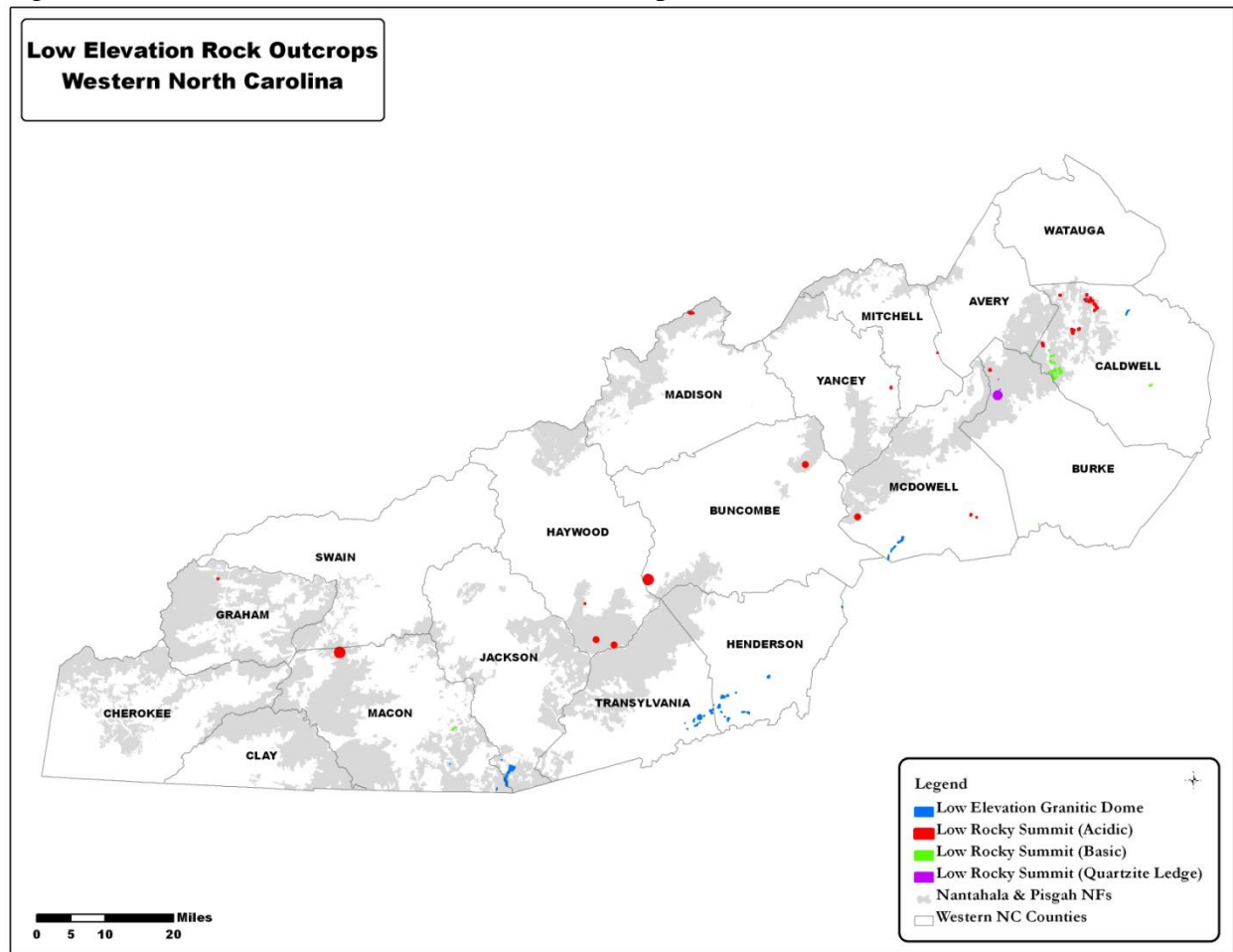
The basic subtype sites are currently only documented in North Carolina and have a global rank of G1. Four sites are known to occur in the planning area, two of which occur partially on national forests; however, these two sites probably represent over 80% of the delineated areas for this subtype.

Low elevation granitic domes occur within the lower elevations of the Blue Ridge escarpment in Macon, Jackson, Transylvania, Henderson, Caldwell and McDowell Counties (Figure 7). These communities are known to occur from Alabama, Georgia and North Carolina in Blue Ridge and upper Piedmont, with possible occurrences in South Carolina (Natureserve 2013). This habitat has a global rank of G2. Twenty sites are known to occur in the 18-county planning area, five of which occur on the Nantahala and Pisgah NFs.

A few rare species are known to occur within these rare habitats. Two federally listed plants are documented in the quartzite subtype of the low elevation rocky summits; both are documented on the Pisgah NF.

All of the low elevation rocky summit quartzite subtype occurs within designated areas. Over three-quarters of the acidic subtypes occurs within designated areas, along with one of the two basic subtype sites and one of the and five granitic dome sites.

Figure 7. Distribution of low elevation rock outcrops in western North Carolina.



Trampling from recreational use poses the greatest threat to these unique habitats (Natureserve 2013). Fire suppression poses a risk with change in species composition with the quartzite subtype of the low elevation rocky summit.

Carolina Hemlock Bluff and Forest:

There are three subtypes of Carolina hemlock (*Tsuga caroliniana*) forest - mesic, typic, and pine- and two subtypes of Carolina hemlock bluffs - typic and pine. Carolina hemlock forests occur within streamside bottoms or sheltered slopes, whereas Carolina hemlock bluffs occur on shallow, rocky soils on exposed ridges or steep slopes (Natureserve 2013). Note that typic and pine subtypes occur in both Carolina hemlock bluff and forest habitats.

Besides Carolina hemlock, chestnut oak can occur as a minor tree component for the typic subtype. A dense ericaceous shrub layer occurs, typically with mountain laurel, punctatum (*Rhododendron minus*), or Catawba Rhododendron. Herbs are sparse within this type although characteristic species include turkey beard (*Xerophyllum asphodeloides*), and bracken fern (*Pteridium aquilinum*). Although rare, the typic subtype is the most common Carolina Hemlock

habitat encountered across its range in the Blue Ridge and upper Piedmont of Virginia, the Carolinas, and Tennessee. This subtype has a global rank of G2.

The pine subtype has a pine component, pitch pine, table mountain pine, or Virginia pine, which can codominate the overstory with Carolina hemlock (Natureserve 2013). A patchy to open shrub layer occurs within this subtype, including punctatum, low bush blueberry, and wintergreen (*Gaultheria procumbens*). One rare plant species, pirate bush (*Buckleya distichophylla*), is known to occur within this subtype in Tennessee. Little bluestem and lichens can dominate within the herb layer of this subtype. This subtype is most common in Tennessee with a few sites in North Carolina. It is also ranked G2.

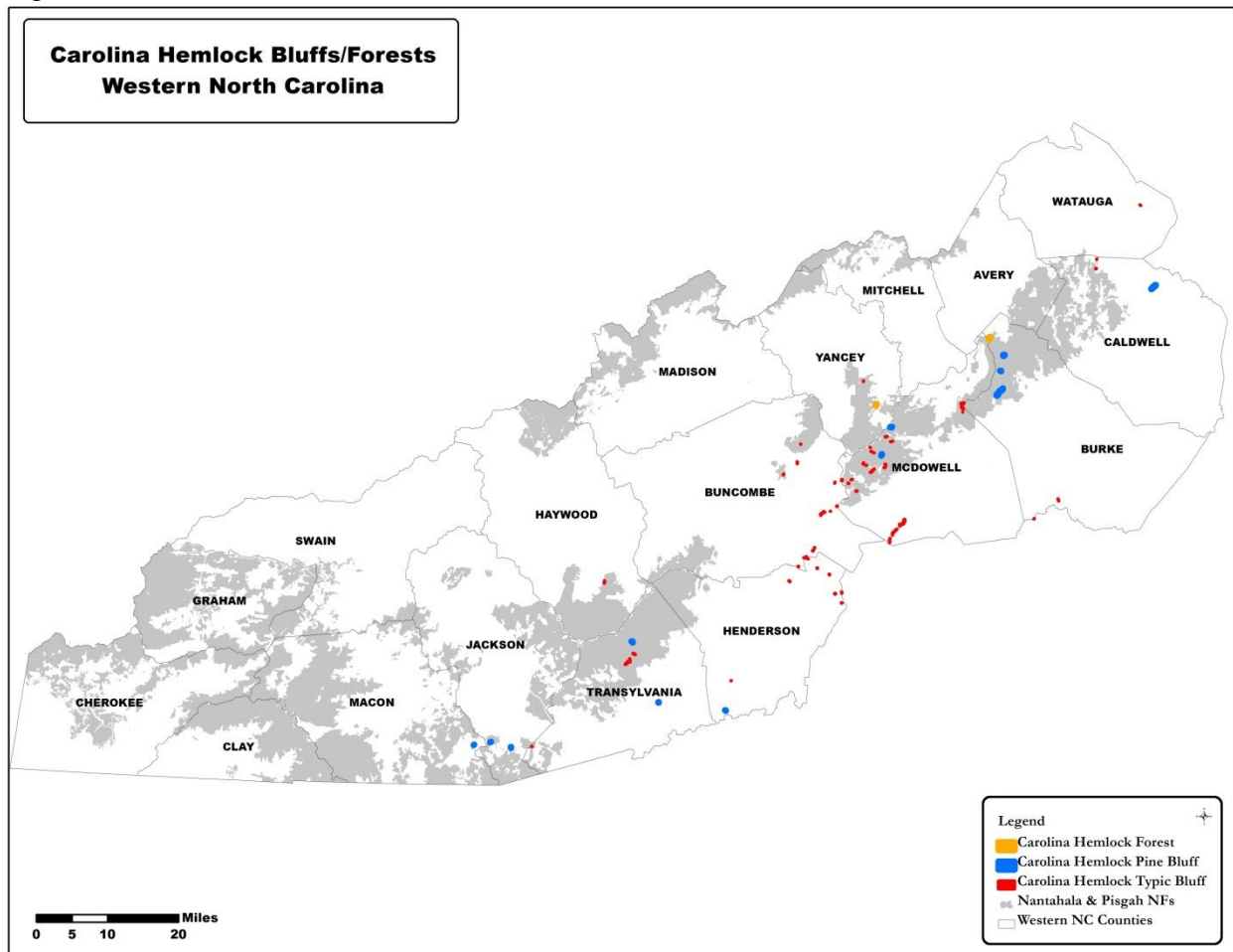
The mesic subtype co-occurs with eastern hemlock and closely resembles a hemlock hardwood forest. Great laurel and dog hobble are often very dense within the shrub layer. Herbs are sparse, with Galax (*Galax urceolata*) being the most common. This represents the rarest subtype with few occurrences in Tennessee and North Carolina. The global rank is G1G2.

In western North Carolina, the vast majority of the occurrences are east and south of Asheville, in Buncombe, McDowell, and Henderson Counties (Figure 8). The typic forest is the most common type and evenly distributed subtype. The pine subtype is dispersed across larger rock outcrops across the Blue Ridge Escarpment but only has a few sites per county. A concentration of this type occurs in the Highlands area. Mesic Carolina hemlock forest is the rarest subtype with only a few occurrences including Greasy Creek in Dupont State Forest, Linville River Falls, and along the Toe River.

Given the continued impact from hemlock woolly adelgids, it is uncertain as to the current condition of all the sites. Aerial photography inspection indicates some dieback of Carolina hemlocks both on public and private lands. Within the Nantahala and Pisgah NFs, the mesic subtype is known from two partial sites, the pine subtype across ten sites, and the typic subtypes across 19 sites. The two national forest units contain slightly less than half of all the Carolina hemlock bluffs and forests within the 18-county planning area. Approximately half of the habitat on the two national forests occurs within designated areas.

No rare species are known to occur within these habitats in North Carolina. Carolina hemlock is currently a Region 8 sensitive plant species and has been petitioned to be listed by the US Fish and Wildlife Service.

Figure 8. Distribution of Carolina hemlock bluffs and forests in western North Carolina.



The greatest threat to the Carolina hemlock forest community is the hemlock woolly adelgid. Control efforts are being completed at sites on the Grandfather, Appalachian, Pisgah, and Nantahala Ranger Districts. Control includes the application of pesticides and the release of predatory beetles, such as *Sasajiscymnus tsugae*, *Laricobius nigrinus*, and *Laricobius oakensis*. While some previously known sites have been lost to the adelgid, the success of the current treatments is being monitored and will be continued to ensure the viability of this unique habitat across the two forest units.

White Pine Forest:

This community is a naturally occurring white pine-dominated forest. It occurs on steep ridges that receive at least half day solar radiation even in highly sheltered gorges, such as in the Horsepasture River or Linville River (Cecil Frost, ecological consultant, personal communication 2010). It can occur on thin soils and is often associated with rock outcrops.

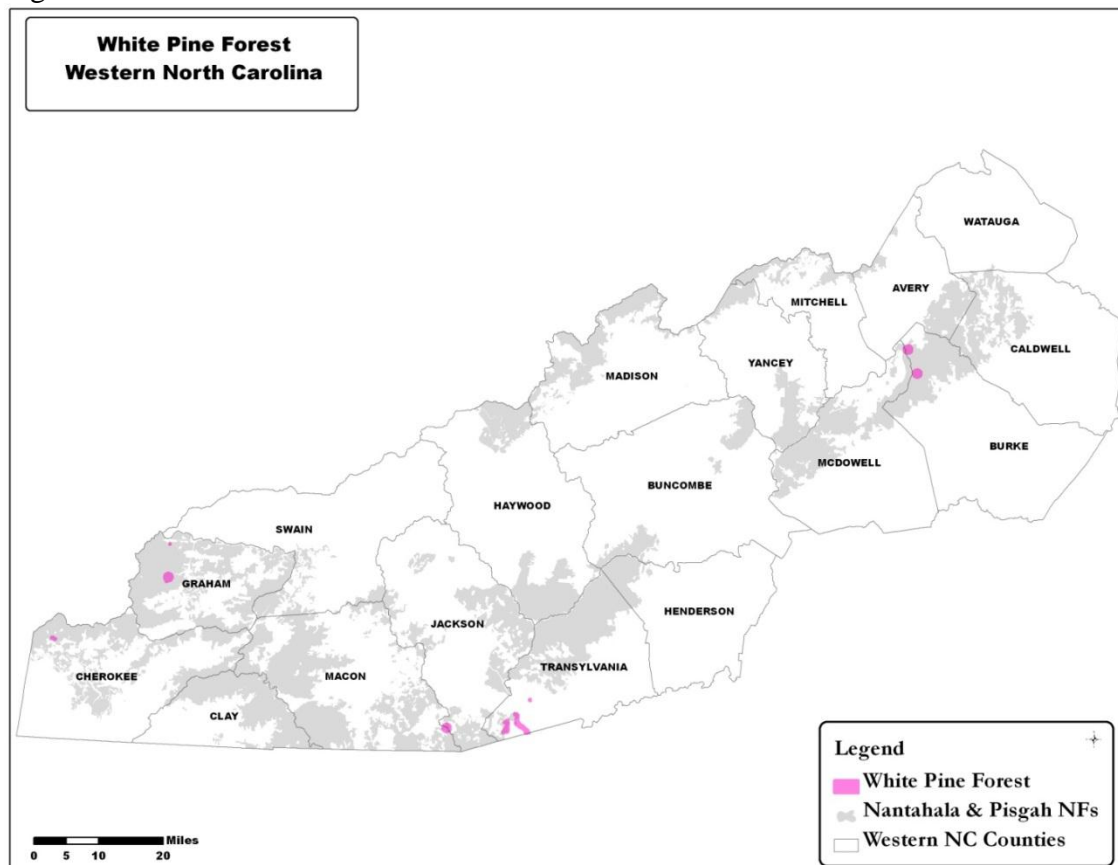
The community is geographically restricted to Tennessee, North Carolina, Georgia, and South Carolina along steep slopes in the escarpment region of the Blue Ridge and the Great Smoky Mountains. The global rank for this habitat is G2G3.

Given prior land use history of planting or favoring white pine as well as fire suppression, it can be difficult to distinguish a natural occurrence from a planted one. However, in steep gorges within inaccessible sites, white pine forests are presumed to be of natural origin (Biotics 2013). There are nine documented sites in North Carolina, eight of which are fully or partially on the Nantahala or Pisgah NFs.

Community composition is variable with minor canopy species including pitch pine, scarlet oak, white oak, and red maple. Shrub density is often high within this habitat, typically consisting of ericaceous species such as mountain laurel, bear huckleberry, and deerberry. Herbs are sparse and include trailing arbutus, whorled loosestrife, rattlesnake plantain, and fairy wand. While rare plants are not specifically known within this community, they can be associated with the rock cliff ecotone. Patch size is variable but mostly less than 10 acres. Multiple patches can occur along a steep slope within a large gorge.

Disturbance dynamics are wind and possibly fire at infrequent frequencies. There are no current threats to this community. Four of the nine sites on the national forests are within currently designated areas.

Figure 9. Distribution of White Pine Forest in Western North Carolina.



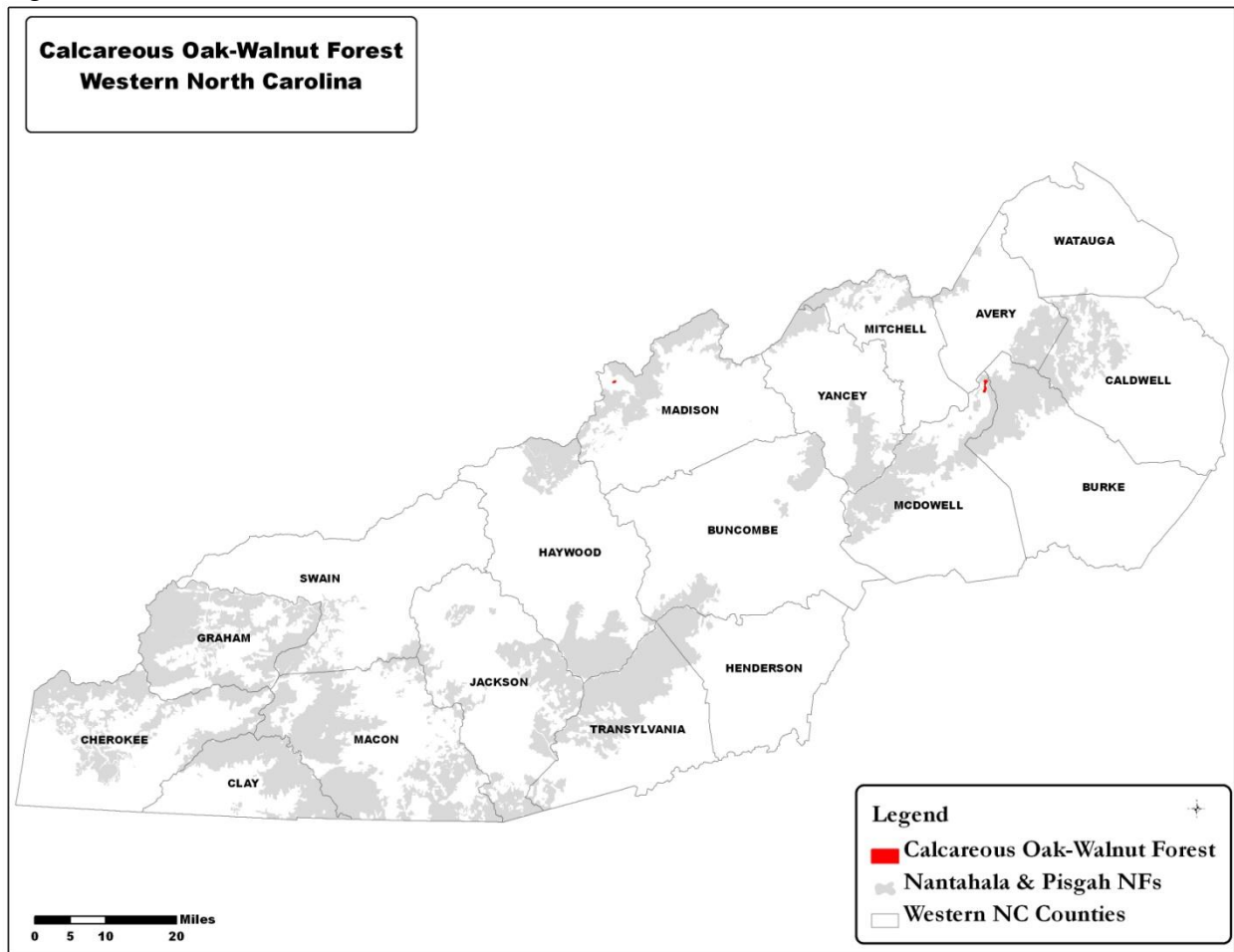
Calcareous Oak-Walnut Forest:

This low elevation forest occurs within sheltered gorge slopes or bottoms influenced by calcareous rocks such as dolomite. Higher calcium content and higher pH, 6.0, provide substrate for a dry-mesic forest dominated by chinkapin oak (*Quercus muhlenbergia*) and red oak, with lesser amounts of black walnut (*Juglans nigra*). Herb diversity is high within these dry-mesic sites and includes species such as white-flower leafcup (*Polymnia canadensis*), *Hybanthus concolor*, and columbine (*Aquilegia canadensis*).

The habitat is restricted to North Carolina and has a global rank is G1Q (questionable taxonomy) (Natureserve 2013). Three separate sites have been delineated (Figure 10). A portion of one site occurs on the Grandfather Ranger District and another is on the Appalachian Ranger District (Biotics 2013, Peet et. al 2013). Neither of these sites is within currently designated areas.

Three rare calcium-loving plant species have been documented at one site. Two of these species flower more abundantly in open habitat and may be present due to nearby montane calcareous cliffs. It is uncertain what disturbance regime the community is adapted to besides tree fall gaps, although the two light-loving rare species are both fire adapted.

Figure 10. Distribution of calcareous oak-walnut forests in western North Carolina.



Serpentine Barrens:

A patchwork of forest, dense grass patches, and partially open woodland occurs across serpentine sites. The dominant rock types, serpentinized dunite and olivine, influence the vegetation on these sites (Hadley 1949). Soils are shallow (0 to 60 cm), and rock outcrops represent between 5 to 10% of the landscape. Soil characteristics reveal higher base saturation, cation exchange capacity, pH, and magnesium relative to surrounding sites (Mansberg and Wentworth 1984).

The woodland is dominated by older, stunted white oaks and smaller, denser pitch pine stems. Shrub cover is sparse, typically occurring in clumps and providing no more than 10% cover. Two common shrub species are stunted clammy azalea (*Rhododendron viscosum*) and ninebark (*Physocarpus opulifolius*). The grass dominance within the herb layer is reminiscent of prairie vegetation and presents a contrast to the regionally typical herbaceous layer consisting of mesophytic, broad-leaved forbs. Big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium* var. *scoparium*), and prairie dropseed (*Sporobolus heterolepis*) are the most dominant grasses.

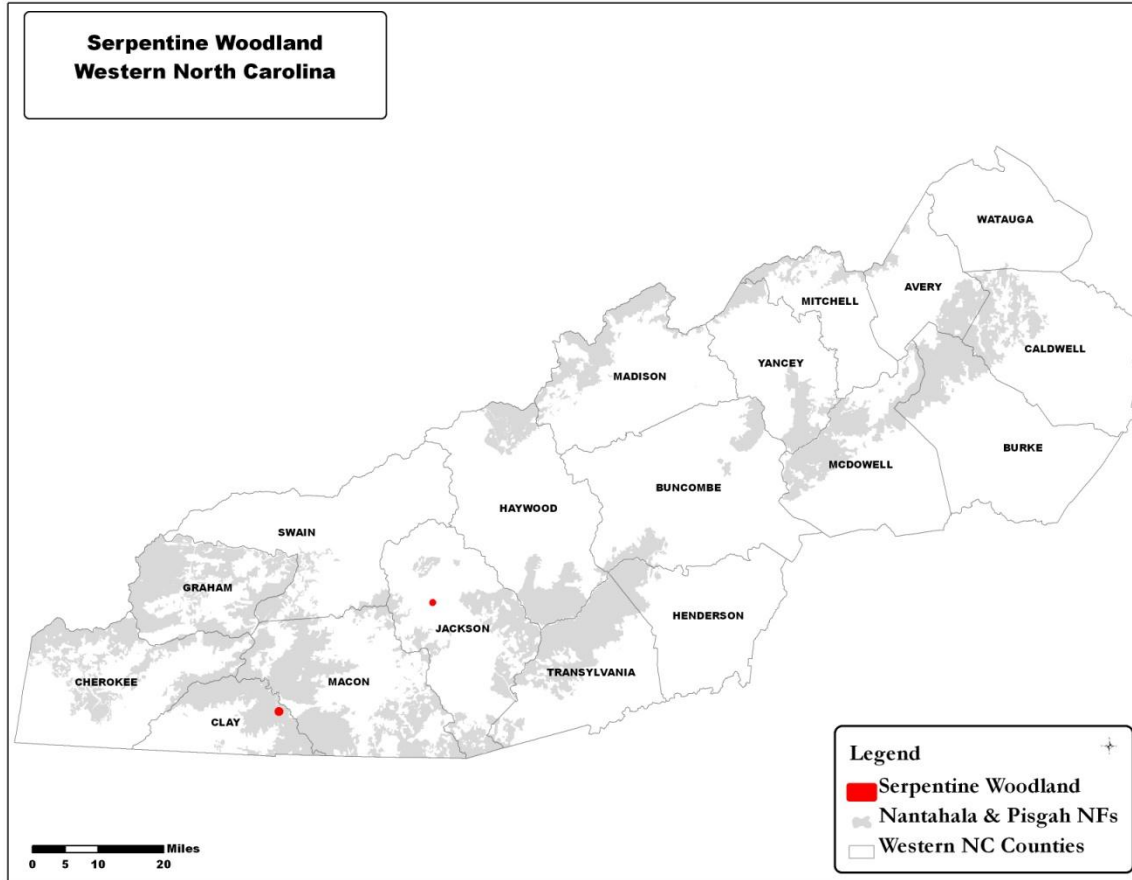
Figure 11. Buck Creek serpentine woodland in mid-August. The dominant grass is *Andropogon gerardii*



This unique plant community has a G1 rank. There are two sites in North Carolina; one is in the Nantahala NF, which represents over 75% of the extent in state (Figure 12). Although serpentine barrens are well-known for their locally endemic species (Brooks 1987), relatively few endemics have been described on the serpentine areas in eastern North America. Within the Buck Creek site, one endemic species, *Symphyotrichum rhiannon*, has been described (Kauffman et. al. 2004). Two other plant species are currently being investigated as potential endemics (Dr. Alan Weakley, UNC herbarium curator, personal communication).

Approximately half of the Buck Creek serpentine site on the Nantahala NF occurs within a designated area. Prescribe burning has been conducted at this site since 1995 and woody species have been significantly reduced as a result of the burns. The majority of the rare species have benefited, specifically the grasses (Marx 2007). The Buck Creek site appears to be stable, and with periodic burns, the community will be maintained. Threats to the community include recreational rock hounding. An inactive mining lease for dunite extraction has been in place for many years.

Figure 12. The extent of serpentine barren sites across western North Carolina.



Low Elevation Glade:

Low elevation glades are gently to moderately sloping outcrops with a mixed structure of grasses, shrubs, and open trees (Schafale 2012, Natureserve 2013). Three subtypes occur within the planning area, distinguished by their substrate and dominant vegetation: montane basic, Biltmore sedge acidic, and grass acidic glade.

The montane basic subtype occurs as small patches ranging from 5-50 acres. Rock spikemoss and grasses dominate the shallow soil mats with other characteristic herbs indicative of the basic rock such as shooting star (*Primula meadia*), cliff stonecrop (*Sedum glaucophyllum*), hairy lip fern (*Cheilanthes lanosa*), or smooth rock cress (*Boechera laevigata*).

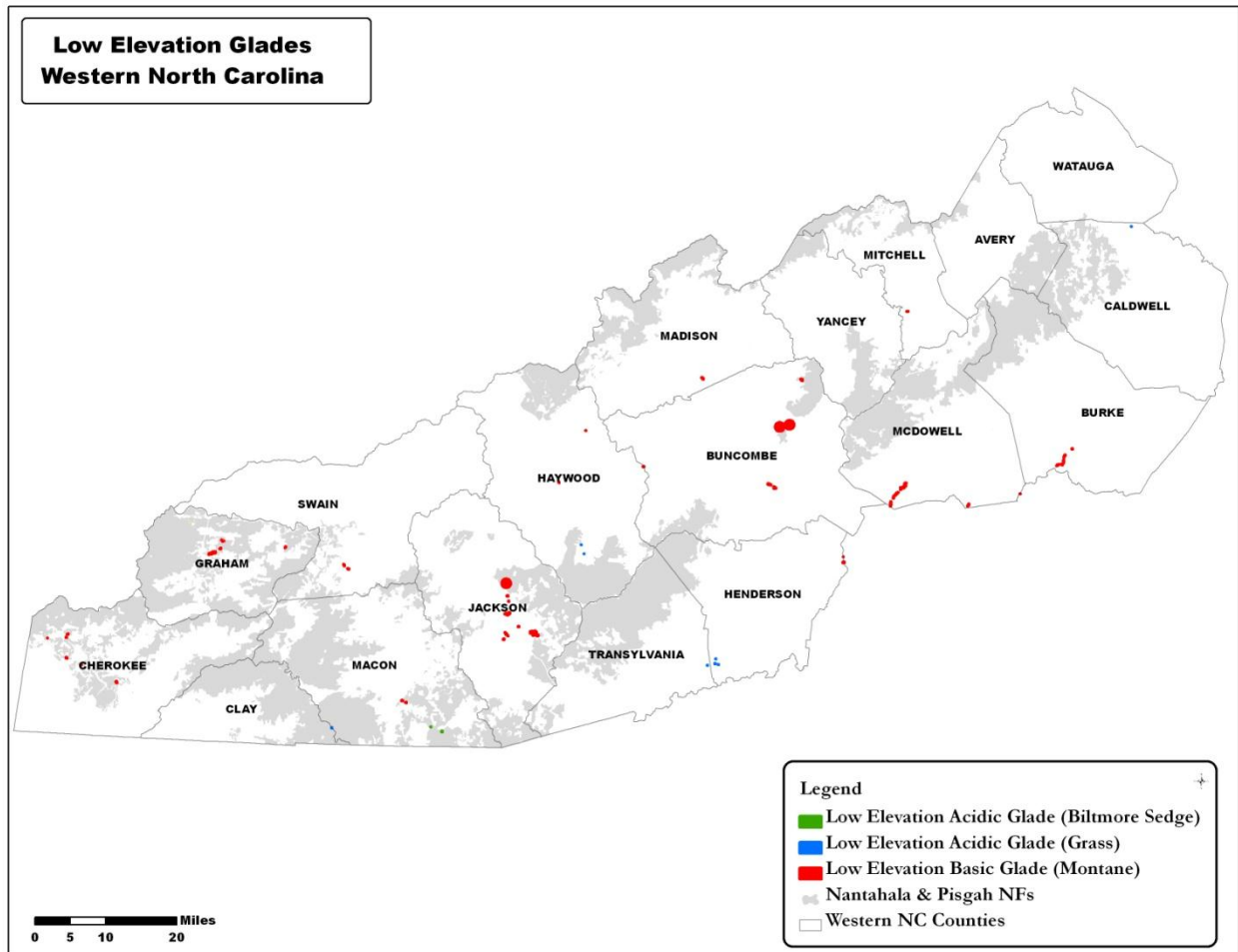
The grass acidic glade subtype is dominated by dry site grasses such as little bluestem (*Schizachyrium scoparium*) and poverty oatgrass (*Danthonia spicata*), with little rock spikemoss. In contrast, the Biltmore sedge acidic glade is distinguished by the presence of abundant *Carex biltmoreana* with scattered mountain dwarf-dandelion (*Krigia montana*) and granite dome bluet (*Houstonia longifolia* var *glabra*). Consequently, the vegetation resembles that found on high and low elevation granitic domes but has very little rock spikemoss (Schafale 2012).

The three subtypes vary in their global rank from G1G2 (grass acidic), G2 (montane basic), and G2G3 (Biltmore sedge acidic). The montane basic subtype is limited to the upper Piedmont and Blue Ridge of the Carolinas and Virginia (Natureserve 2013). The Biltmore sedge acidic glade subtype is restricted primarily to the southern Blue Ridge escarpment in North Carolina, South Carolina, and Georgia. The grass acidic glade subtype is known to occur only in North Carolina, in Transylvania, Henderson, and Macon Counties. Within western NC, the montane basic subtype is the most common, with 34 separate sites occurring over many of the 18 counties, twelve of which occur on the Nantahala and Pisgah NFs. The acidic subtypes are much less common in the planning area. Nine grass subtypes occur within the planning area, one of which occurs on the Nantahala NF. Only three Biltmore sedge subtypes have been identified, two of which are on the Nantahala NF.

A moderate number of rare plant species are known to occur across glade habitats. No federally listed plants are documented within these habitats. Both of the acidic glade subtype sites occur in designated areas on the Nantahala NF. In contrast, none of 12 montane basic subtype sites on the two national forests occur within designated areas.

Given the spectacular views present at many of these sites, trampling from recreational use poses the greatest threat to these rare habitats (Natureserve 2013). However on the national forests, these sites occur in remote locations and therefore do not receive much visitation. The role of fire in these communities is uncertain and it is thought that fire suppression may be changing the vegetation composition (Natureserve 2013).

Figure 13. Distribution of low elevation glades in western North Carolina.



Red Cedar-Hardwood Woodland/Shale Slope Woodland:

Three separate communities comprise this group, including montane red cedar-hardwood woodlands, acidic shale slope woodlands, and calcareous shale slope woodlands. These communities are grouped due to a similar partially open structure with an embedded rock component. The rock component for the two shale subtypes is less consolidated resulting in thin soils that help to maintain a more open canopy structure (Natureserve 2013). Montane red cedar-hardwood woodlands occur on steep south-facing slopes with a complex of rock outcrops, woodlands and denser grasslands (Small and Wentworth 1998).

The two shale subtypes are distinguished by the dominant rock type which influences which plant species are present at the sites. Acidic habitats are dominated by open canopies of Virginia pine, chestnut oak, and red oak while the calcareous sites may include red cedar, a diversity of hickories, and American ash. Both sites have a high diversity of grass species although the calcareous habitats have much greater diversity of herb species and ferns. Lichens can be abundant on the acidic scale habitats. Montane red cedar communities are typically dominated by

red cedar with a variety of hardwoods including American ash, hop hornbeam (*Ostrya virginiana*), and fringetree (*Chionanthus virginicus*). Grass, fern and herb diversity is high on these sites.

These communities have a restricted range and a global rank of G2. The montane red cedar type only occurs in North Carolina and Georgia, while the two shale types occur from North Carolina to Tennessee, and Virginia. In North Carolina, the two shale subtypes occur only in the Hot Springs area, while the montane red cedar type is primarily restricted to the Blue Ridge Escarpment (Figure 14). The national forests have all the occurrences in NC for the calcareous shale woodland subtype and more than 70% of the acidic shale habitat. About 1/3 of the montane red cedar-hardwood communities in NC are present on the Nantahala NF. No occurrences are known to occur on the Pisgah NF.

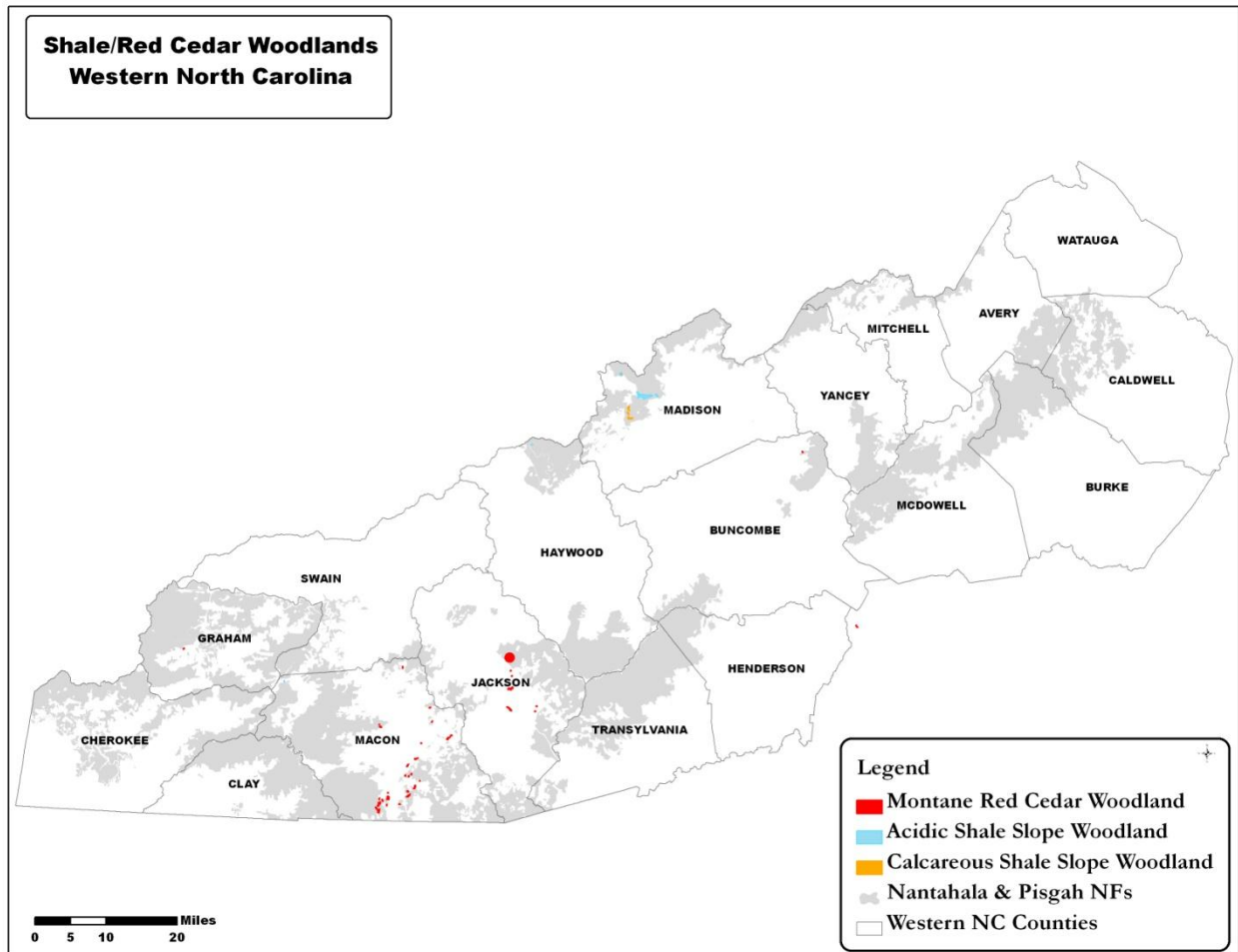
Numerous rare plant species occur in these communities, particularly under open conditions. No federally listed rare species have been located within these types. One rare animal species, the tawny crescent butterfly, has been documented within the red cedar-hardwood community.

At the present time, these sites appear stable; however, little is known about the long-term history of the sites. Most of the rare plant species are adapted to open or partially open conditions and are fire-adapted. It is uncertain what the natural disturbance regime is within these sites. The steep shale slopes result in minimal tree growth and a partially open canopy structure for herbaceous plants to thrive. Some of the common and rare plants include fire adapted species which may benefit from periodic wildfires. It is uncertain what the historic fire frequency is.

The same dynamic and fire uncertainty is evident within the red cedar woodland; however, red cedars are not adapted to fire and may be eliminated with a moderate to high intensity burn (Curtis 1959). Given the juxtaposition of rock outcrop, woodland, and grassland within this community, a hot, continuous fire would be less likely to occur within these sites. These sites may serve as sites of refugia from fire, since many of the sites contain mature red cedars (Small and Wentworth 1998). The greatest threat to these communities is trampling within the rock outcrops and introduction of non-native invasive plant species.

Less than 5% of the montane red cedar-hardwood woodlands occur within designated areas. Between 5-10% of the two shale slope subtypes occur within designated areas.

Figure 14. Distribution of montane red cedar-hardwood or shale slope woodlands in western North Carolina.

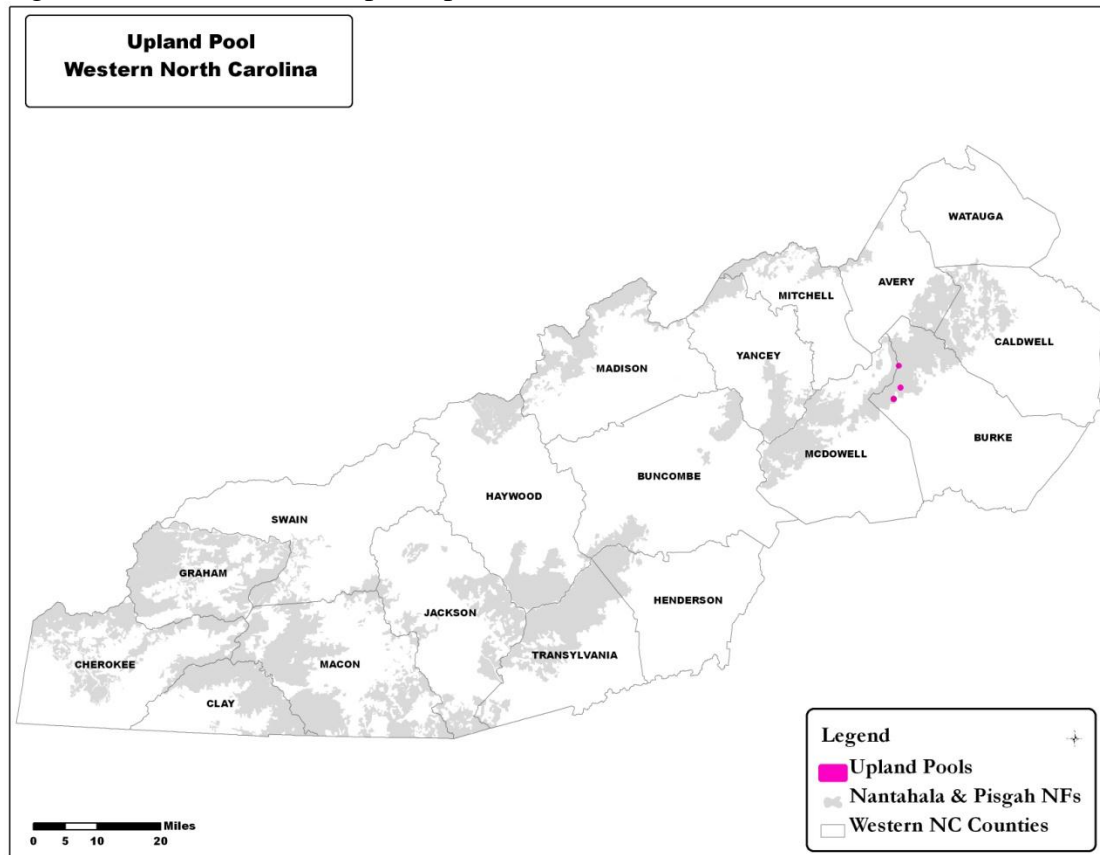


Upland Pools:

Upland pools are small depressions, less than a half acre, occurring on flat portions of broad ridges. An impermeable soil layer inhibits or prevents drainage that pools water all winter and most of the cooler spring and fall months (Natureserve 2013, Newell and Peet 1995). Upland pools may completely dry out in the summer, although the seasonal pooling prohibits tree and shrub growth. These sites are dominated by wetland plants, including wool grass (*Scirpus cyperinus*), three-way sedge (*Dulichium arundinaceum*), and common rush (*Juncus effuses* var. *solutus*). Mats of sphagnum moss occur throughout the pools. These areas provide important breeding grounds for amphibians.

This habitat is exceedingly rare in the southern Appalachians. This habitat has a global rank of G1Q and is limited to western North Carolina. Three uplands pools have been documented within western North Carolina, all of which occur in the Linville Gorge Wilderness area on the Grandfather Ranger District. All three of these sites occur in designated areas.

Figure 15. Distribution of upland pools in western North Carolina.



Southern Appalachian Bogs:

Mountain bogs occur in flat or gently sloping portions of the landscape with poorly drained, saturated soils (Schafale and Weakley 1990). Although associated with streams or rivers, they are generally not subject to flooding. Southern Appalachian bogs are groundwater dependent and floristically similar to the low nutrient, low pH bogs of the northeastern US. Four bog types are identified: Southern Appalachian bog, swamp forest bog complex, French Broad Valley bog, and low mountain seepage bog.

Southern Appalachian bogs and swamp forest bog complexes occur on the national forests. Both of these types are further delineated. The two Southern Appalachian bog subtypes, low elevation and typical, are known to occur on the Nantahala and Pisgah NFs. The two differ primarily by elevation and the presence of southern or northern wetland species (Schafale 2012). The low elevation subtype generally occurs below 3,000 feet elevation north of Asheville and below 3,700 feet elevation south of Asheville. Both subtypes are dominated by Sphagnum moss species. Species more common in the low elevation subtype includes royal fern (*Osmunda regalis*), cottongrass (*Eriophorum virginicum*), and various sedges such as *Carex atlantica* and *C. folliculata*. In contrast, the typical subtype includes more a mixture of shrubs and herbs with characteristic species such as cinnamon fern (*Osmundastrum cinnamomeum*), red spruce, crested

wood fern (*Dryopteris cristata*), silky willow (*Salix sericea*), spotted saint-john's-wort (*Hypericum punctatum*), and star sedge (*C. echinata*).

There are two swamp forest bog complex subtypes, spruce and typic, are mostly in closed canopy condition. Both of these subtypes have a dense shrub layer, typically *Rhododendron maximum*, with small boggy openings dominated by Sphagnum moss. Both subtypes have a closed to partially open canopy with pitch pine, eastern hemlock, black birch, yellow popular, and white pine. The spruce subtype occurs at higher elevations and is co-dominated with red spruce in the canopy.

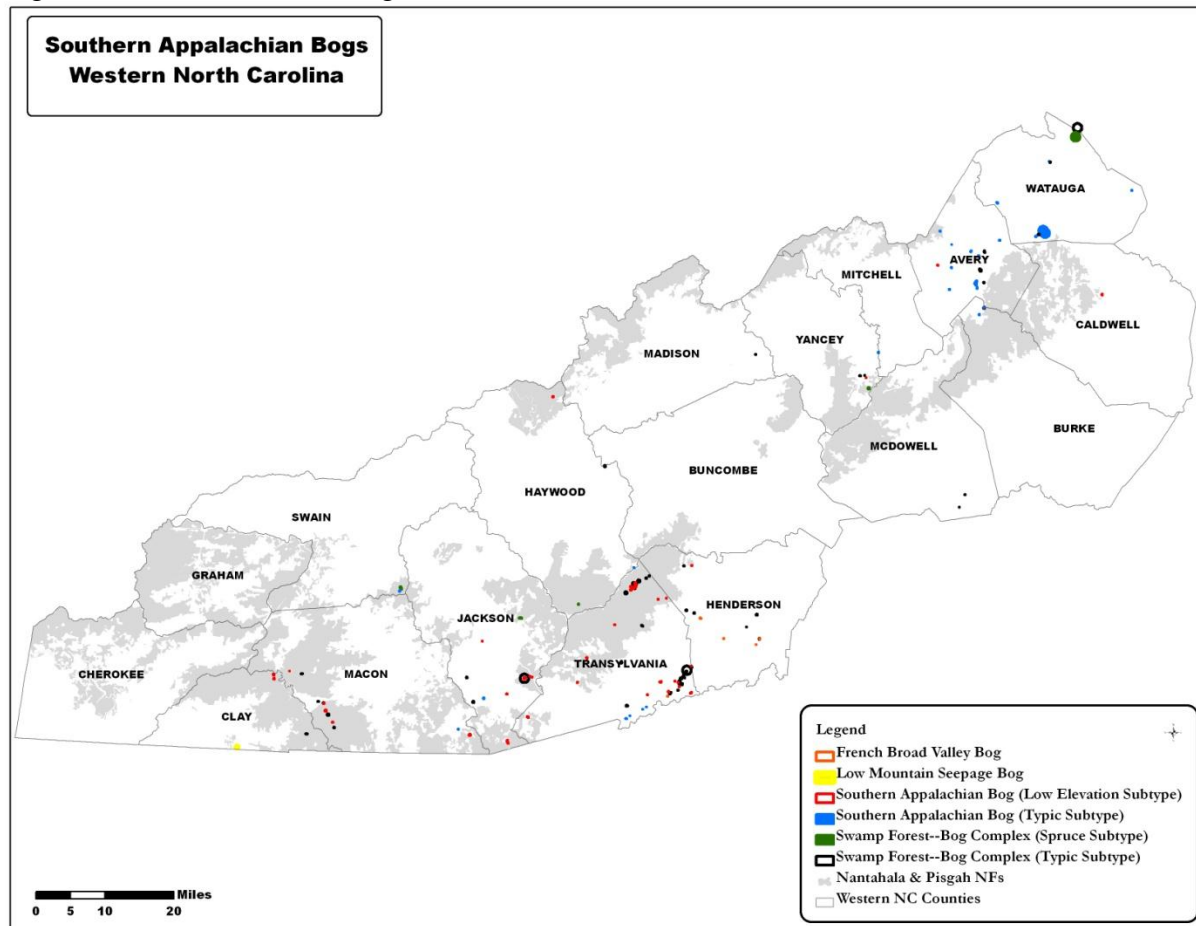
In western North Carolina, bogs are concentrated in six counties: Watauga, Avery, Henderson, Transylvania, Jackson, and Macon (Figure 16). There are no French Broad Valley bogs or low mountain seepage bogs on the national forests. On the national forests the majority of the bog sites are the low elevation subtype of Southern Appalachian bog, with 15 documented sites. In comparison, on lands outside the national forests, there are 32 known sites of this subtype, with the majority in private ownership. Three typic Southern Appalachian bogs subtype have been identified on the Nantahala and Pisgah NFs, while 21 are known to occur on other lands, primarily on private ownership. There are 41 typic swamp forest bog complexes known in the 18-county area, 15 of which occur on the Nantahala and Pisgah NFs.

A large number of rare species are known to occur within these habitats. Four federally listed plants are documented in bogs, one of which (Swamp pink), has been documented on the national forest.

Most of these rare plant species are only found in open bog sites, which mostly occur in the Southern Appalachian bogs; however, a few can be found in swamp forest bog complexes, including the federally threatened swamp pink. The majority of the rare species flower more prolifically and appear to have larger populations in Southern Appalachian bogs with high light levels. Rare animals that occur within these habitats include southern bog turtles.

For the Southern Appalachian bogs, four of the 15 low elevation subtype sites occur within designated areas on the Nantahala and Pisgah NFs. Three of the nine typic subtype sites occur in designated areas. For the swamp forest bog complexes, 20% of the spruce subtype and about 60% of the typic subtype occur in designated areas.

Figure 16. Distribution of bog habitat in western North Carolina.



Bogs have been present within western NC for thousands of years. Recent carbon dating at one Nantahala NF bog indicates an age greater than 8,000 years (Dr. Benjamin Tanner, Western Carolina University geology professor, personal communication). Bog communities have been negatively affected more than any other rare habitat in the southern Appalachians. Estimates of former bog acreage indicate that only 10% of the historic acreage remains (Noss et al., Weakley and Schafale 1994). Hydrological changes and land conversion have been the primary impacts in the past. Present threats to this community include woody plant invasion, particularly shrubs in the Southern Appalachian bog subtypes, non-native plant species competition, nutrient influx, grazing, and modification of natural disturbance regimes. The latter threat may be the absence of fire although there is disagreement among bog land managers about management options as well as desirable shrub densities.

Seeps:

Seeps represent a very diverse group of small habitats ranging from low to high elevations and occur in headwater streams, in floodplains, or over bedrock (Natureserve 2013, Schafale 2012).

Both mid to high elevation examples occur in stream headwaters. High elevation boggy seeps are dominated by sedges and grasses with a *Sphagnum* component. In contrast, rich montane seeps do not have *Sphagnum* spp.; rather they are dominated by various herbaceous species such as green-headed coneflower (*Rudbeckia laciniata*), bee balm (*Monarda didyma*), false nettle, umbrella-leaf (*Diphylleia cymosa*) lettuce saxifrage, and (*Micranthes micranthidifolia*). Both of these subtypes are small and surrounded by either spruce-fir, northern hardwood, or rich cove forests.

Four subtypes have been described for low elevation seeps. The typic subtype occurs on slope breaks, toe slopes, or in floodplains in the Piedmont and mountains. It may include other wetland species within swamp-forest bog complexes but also include less nutrient depleted species such as Virginia water horehound (*Lycopus virginicus*) and spicebush (*Lindera benzoin*). The montane low elevation seep can also occur on slopes but also on small streamheads, or in cove bottoms. Characteristic species include smooth turtlehead (*Chelone glabra*), *Carex gynandra*, and fowl mannagrass (*Glyceria striata*). The bedrock subtype is associated with rock outcrops, often granitic dome, and can include roundleaf sundew (*Drosera rotundifolia*), cowbane (*Oxypolis rigidior*), small green wood orchid (*Platanthera clavellata*), and bushy bluestem (*Andropogon glomeratus*). The mountain springhead subtype includes characteristic seep wetland flora mixed in more characteristic coastal plain species such as carbriar (*Smilax laurifolia*) and possumhaw (*Viburnum nudum*).

The geographic range and rarity of the seeps vary. High elevation seepy bogs are restricted to the southern Blue Ridge within North Carolina and Tennessee and rich montane seeps occur in Virginia and Georgia. The global rank for high elevation seepy bogs is G2, and for rich montane seeps is G3 (Natureserve 2013). Both of these subtypes are the most common delineated seeps in western North Carolina, particularly the rich montane (Figure 17). Fourteen high elevation seepy bog sites have been documented across the planning area, a portion of all but one occurs within the Nantahala and Pisgah NFs. Within the 18-county planning area, 23 rich montane seep sites are known, 20 of which occur on the Nantahala and Pisgah NFs.

Low elevation seep subtypes are much sparser within the planning area: two for the typic and springhead subtypes, three for the bedrock, and four for the montane (Figure 1). These subtypes have a slightly larger geographic range, also occurring in the Piedmont, but have low global ranks ranging from G2 to G3.

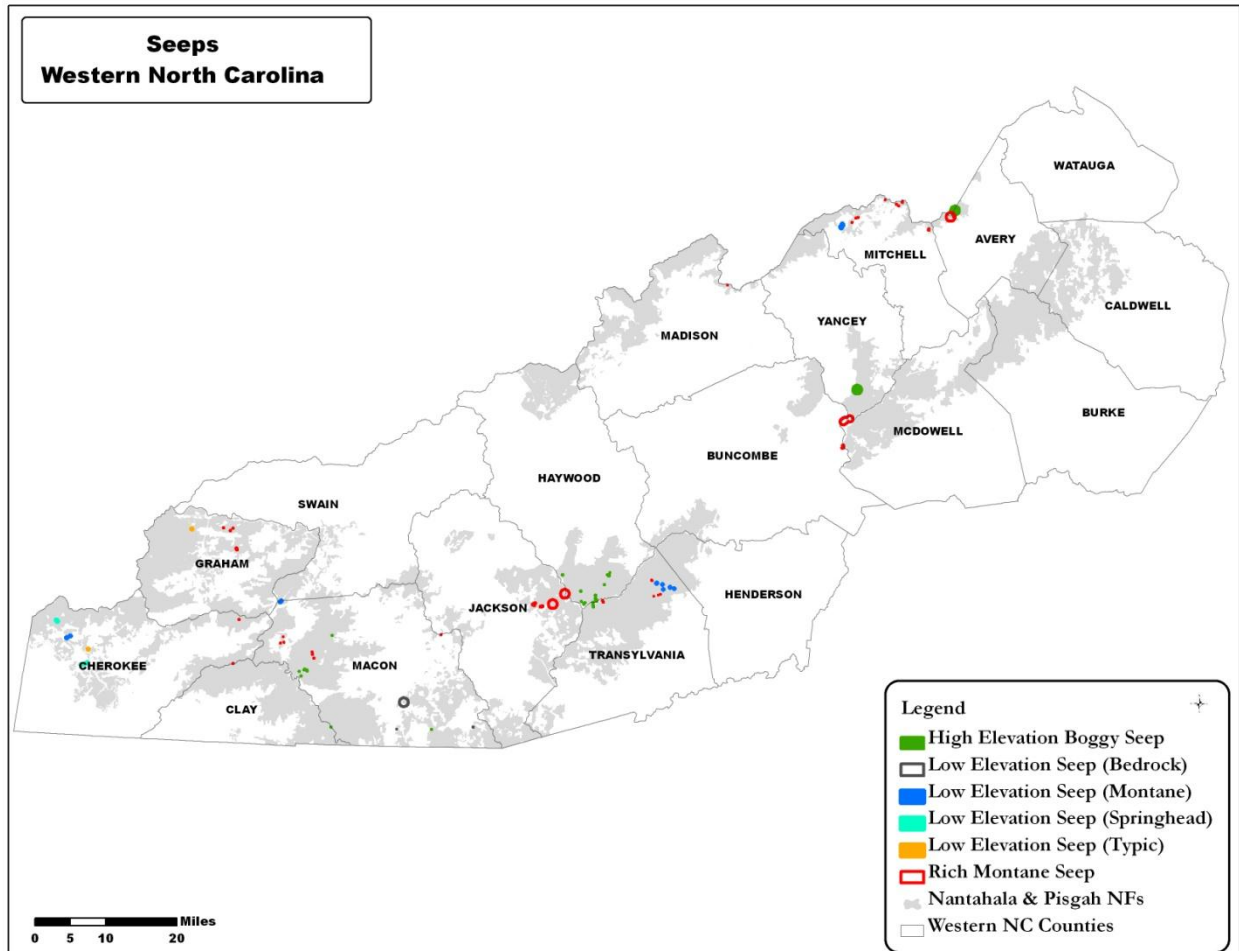
No federally endangered plants have been documented in seep communities on the Nantahala and Pisgah NFs. Other rare species have been documented, including one liverwort, three mosses, seven graminoids, 20 herbaceous plants, and two shrubs.

Over 80% of the high elevation boggy seep sites occur in designated areas on the forest. In contrast, 15% of the rich montane seeps occur in designated areas. One of the four low elevation seep subtypes (montane) occurs within a designated area.

By identifying these as rare habitats, impacts have been avoided. Most of the impacts to these habitats have resulted from past land-use, particularly for the low elevation types. Few threats exist to seeps within the high and mid elevation types. Riparian standards in the current forest

plan exclude impacts to seeps by eliminating trail or road construction across the habitat. Trampling within the bedrock subtype can impact the vegetation and transport non-native invasive plant species. Hydrological changes upslope or upstream has the potential to impact any of the seep communities.

Figure 17. Distribution of seeps in western North Carolina.



Spray Cliff:

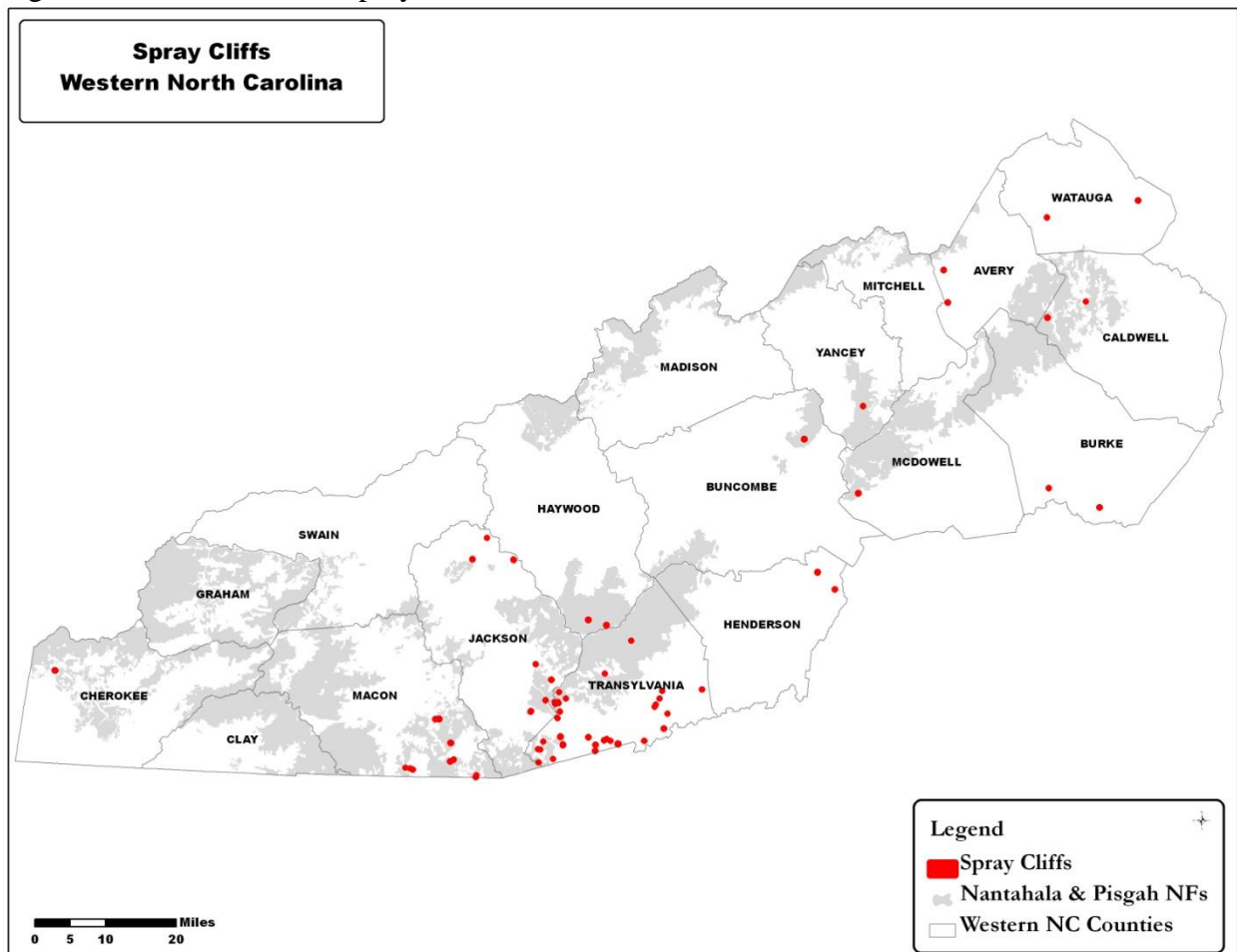
Spray cliff plant communities occur on rock outcrops associated with waterfalls. Consequently, they have very high moisture content with small annual fluctuations in temperatures (Billings and Anderson 1966). Varying size grottoes with damp and dark conditions are associated with these communities. These communities are best developed on the steep slopes of the Blue Ridge Escarpment (Zartman and Pittillo 1998). Herbs and nonvascular plants are the primary dominants within this diverse type, with occasional shrubs. Nine separate associations were determined in a study across a small portion of the escarpment (Zartman and Pittillo 1998). Typical species included three nonvascular, *Thuidium delicatulum*, *Atrichum oerstedianum*, *Plagiomnium ciliare*, and two vascular species, creeping bluet (*Houstonia serpyllifolia*) and cave alumroot (*Heuchera parviflora*).

This community is primarily restricted to the Carolinas, Georgia and Tennessee with small scattered occurrences. The global rank is G2 due to the small occurrences (Natureserve 2013). In western North Carolina, the best examples of this type are concentrated in three counties, Transylvania, Jackson, and Macon (Figure 18). Twenty-one sites have been documented across the Nantahala and Pisgah NFs. Within the 18 county-area, another 31 sites occur on other lands.

One federally endangered plant, rock gnome lichen, has been documented in spray cliffs on the Nantahala and Pisgah NFs. Thirty-two other rare species have been documented, consisting of 11 liverworts, 14 mosses, six ferns or fern-related plants, and one grass.

Of the 21 sites documented on the Nantahala and Pisgah NFs, 11 are currently within existing designated areas. The greatest threat to spray cliffs is from recreational impacts, visitors trampling on the grotto floors, as well as potentially transporting non-native invasive plant species.

Figure 18. Distribution of spray cliffs in western North Carolina.



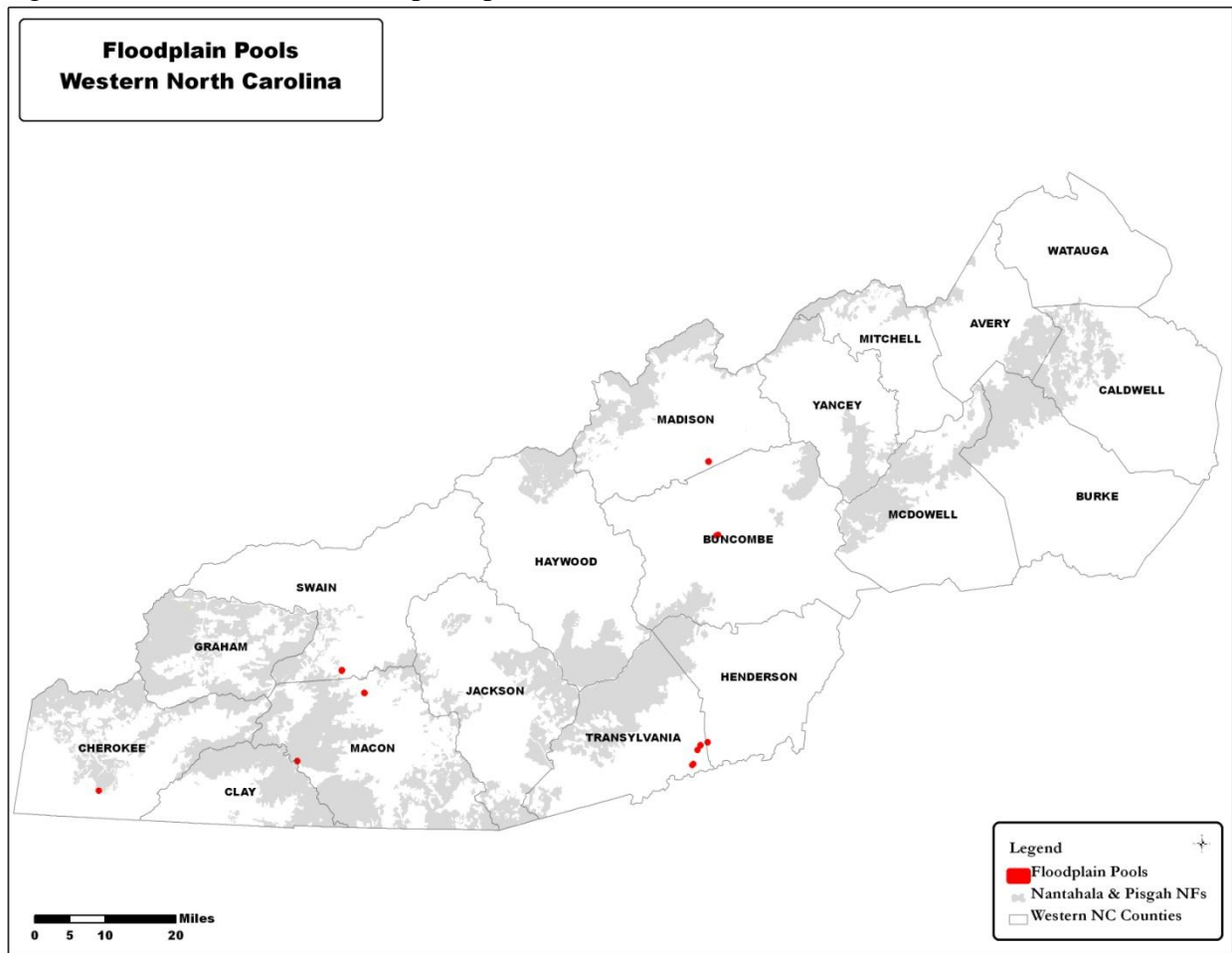
Floodplain Pool:

Floodplain pools are transitional communities between aquatic and wetland vegetated communities (Natureserve 2013). They are in narrow sloughs or rounded depressions of typically abandoned floodplains (Schafale 2012). Water is supplied by stream flooding and rainfall. Sparse emergent aquatic vegetation is present in the shallow portion of the pool. The small communities are typically shaded by floodplain forests. Depending on the frequency of larger floods, the vegetation can be ephemeral as the pool size fluctuates. Sedges such as *Carex crinata* or *C. folliculata* are often present, as is three-way sedge (*Dulichium arundinaceum*), water-willow (*Justicia americana*), and small-spike false nettle (*Boehmeria cylindracea*). The moss *Climacium americanum* is often abundant on the edge of the pool. Annuals and biennial herbs as well as non-native invasive plant species, such as Japanese stiltgrass (*Microstegium vimineum*) can be abundant. Two subtypes are known, those that do not dry out and maintain pools year round and those that can occasionally dry between floods (Schafale 2012). The two subtypes differ primarily in their aquatic animal dominance.

This community has a somewhat broad range, from the southern Blue Ridge Piedmont and Piedmont in North Carolina, north to the coastal plain in Connecticut. The global rank is G3 due to the scattered small occurrences (Natureserve 2013). In western North Carolina, there are nine recently documented examples of this type. They are restricted to the French Broad River system, the Nantahala River, the Little Tennessee River, and Hiwassee River (Figure 19). Only one site has been documented within the Nantahala NF.

No federally endangered plants have been documented in floodplain pools in the Nantahala NF. There are no known rare plant species documented within the habitat although the habitat is important for aquatic animals and amphibians. The single site documented on the Nantahala NF is not within an existing designated area. The greatest threat to floodplain pools is from hydrological changes affecting the persistence of the pools.

Figure 19. Distribution of floodplain pools in western North Carolina.



Rocky Bar and Shore/ Semi-permanent impoundments:

Rocky bar and shore habitats occur in sand or gravel bars, in or along small rivers and streams (Schafale and Weakley 1990). Structural and vegetation dynamics, and sediment input are determined by the frequency of flooding. Severe flooding may damage some bar habitats while also creating new young bars in other portions of the drainage. Three rocky bar and shore subtypes are known to occur on the Nantahala and Pisgah NFs: alder-yellowroot, twisted sedge, and river bar woodland. Black alder (*Alnus serrulata*) and yellowroot (*Xanthorhiza simplicissima*) dominate the dense shrub layer mixed in with open patches of grasses and forbs, including American groundnut (*Apios americana*), deer tongue grass (*Dichanthelium clandestinum*), and green-headed coneflower (*Rudbeckia laciniata*). Occurrences vary from a few meters in width to 10-20 meters (Natureserve 2013). In contrast, the twisted sedge (*Carex torta*) subtype occurs in small linear patches in areas with frequent flooding. The river bar woodland is variable in structure, depending on the frequency and intensity of flooding events. Sycamore and river birch typically occur within an open structure with a diverse herb layer. This

subtype is believed to be slightly more common across its range, with a G4 rank while the other two are ranked G3G4.

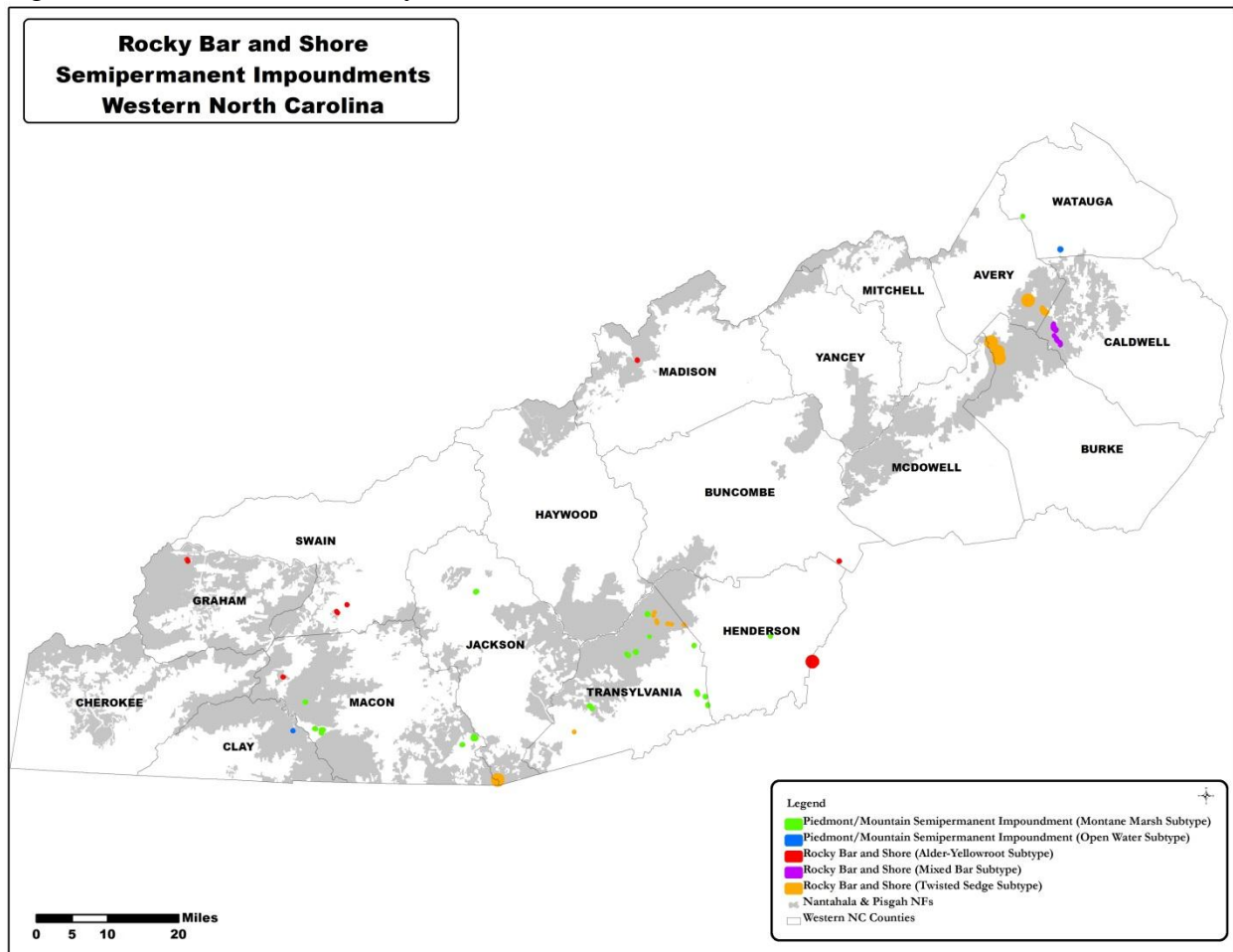
Two of the semi-permanent impoundments subtypes, open water and montane marsh, are known from the Nantahala and Pisgah NFs. The two differ by the degree of water and flooding present. Both can be derived and influenced by beaver activity (Scahafale 2012). The montane marsh is Scattered submergent vegetation occurs within the open water subtype while wetland herbs such as common rush (*Juncus effusus*), turtlehead (*Chelone glabra*), various bulrushes (*Scirpus* spp.) and sedges dominate the marsh subtype. The two semi-permanent impoundment subtypes are not as common in western North Carolina as the three rocky bar and shore subtypes. However the open water subtype is quite common across its range in the Piedmont and mountains with a G4G5 rank. In contrast the montane marsh habitat has a much more restricted range with a global rank of G2G3.

In western North Carolina, these habitats are distributed across the larger river systems such as Wilson Creek, Linville River, Catawba River, Nolichucky River, Little Tennessee River, Chattooga River, Davidson River, upper and lower French Broad River, Nantahala River, Buck Creek, and Cheoah River (Figure 20). In North Carolina, all the mixed bar subtypes are documented within either the Nolichucky River or Wilson Creek, with about half of the occurrences on national forest land (Brown 2002). Of the 11 other two subtypes delineated in the planning area, 75% occur within the national forest. In contrast, almost all of the semi-permanent impoundments occur on private lands, with only about 35% on national forest lands.

A moderate number of rare species are known to occur within these habitats. One federally listed plant documented along a rocky bar on the national forest is Virginia Spiraea (*Spiraea virginiana*).

Approximately 85% of the rocky bar and shore sites are contained within designated areas. In contrast, less than 10% of the two semi-permanent impoundment subtypes are contained within existing designated areas.

Figure 20. Distribution of rocky bar and shore habitats in western North Carolina.



Hydrological changes and land conversion were the primary previous impacts to the creation and maintenance of this habitat group. Several of the subtypes are still affected by modified stream flows as a result of constructing reservoirs and generating hydroelectric power. Currently, many of the subtypes are impacted by non-native invasive plant species.

Caves/Mines:

This group includes both natural caves and mines. Caves in the planning area differ by how they are formed, either as a solution cave or a fissure cave. In addition, caves can be grottoes or rock shelters. Solution caves form as a result of water slowly dissolving the underlying rock to form tunnels that gradually enlarge. These types typically form in limestone formations and are most visible in the planning area in the Nantahala Gorge and the North Fork of the Catawba River and Linville Mountain. In contrast, fissure caves are formed from the earth's movement creating cracks in the rock, and can be of various sizes and configurations. The area of greatest concentration of fissure caves in North Carolina is on the periphery of the planning area on the southern border of Henderson and Rutherford County in the Hickory Nut Gorge.

Boulder caves or rock shelters are formed from a number of factors, erosion forces, extreme weather, earth movement, all of which can form spaces underneath or behind surface rock. Rock shelters are the most common type of cave within the planning area and across North Carolina.

In addition, various sized mines have created subterranean cavities which can mimic natural caves. Only those abandoned mines which previously created excavations suitable for animal habitat are of interest for this grouping with natural caves.

Incomplete information is known about all the caves and mines on the two national forests. Various solution caves are known in the Nantahala Gorge area. No fissures caves are currently mapped on the Nantahala and Pisgah NFs. Mines are documented across the planning area, although the presence of excavations suitable for animal habitat is unknown. Figure 21 displays an incomplete map of those currently documented caves and mines.

Caves and mines can provide habitat for various bats, invertebrates and salamanders. Partially open rock shelters can provide habitat for lichens, mosses and liverworts, and gametophytic ferns; however, completely dark habitats have limited to no plant diversity. No cave obligate plant species are known in western NC. Rare species within caves include three federally listed bat species. An initial inventory of bat-occupied cave and mines across the two forest units has occupied habitat for eight caves and four mines.

Threats to cave habitats include recreational cavers disrupting hibernating patterns, as well as spreading white-nose syndrome to bat populations. In order to minimize spread of the disease, a closure order has been issued across all of Region 8 for all caves and mines, and is in effect until May 21, 2014. No-one is allowed within the caves or mines unless for rescue purposes or authorized by a Forest Service officer. Bat friendly gates have been installed on some of the mines and caves across the Nantahala and Pisgah NFs.

Figure 21. Caves and mines distributed across western North Carolina.

